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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

FIREPASS IP HOLDINGS, INC. and FIREPASS CORPORATION,

Plaintiffs,

- against -

AIRBUS AMERICAS, INC., AIRBUS S.A.S., and PARKER HANNIFIN CORPORATION,

Defendants.

09 4234

COMPLAINT FOR PATENT INFRINGEMENT AND DEMAND FOR JURY TRIAL

VITALIANO, J.

Civil Action No. ___________

POHORELSKY, M.J.

Plaintiffs Firepass IP Holdings Inc. ("Firepass Holdings") and Firepass Corporation ("Firepass") (collectively referred to as "Plaintiffs"), by way of this Complaint against Defendants Airbus Americas, Inc. ("Airbus Americas"), Airbus S.A.S. ("Airbus Parent") (collectively referred to as "Airbus") and Parker Hannifin Corporation ("Parker"), hereby allege with knowledge with respect to its own acts and upon information and belief with respect to all others:

NATURE OF THE CASE

1. This is a civil action for infringement of one or more of United States Patent No. RE 40,065 ("the '065 patent"); United States Patent No. 6,418,752 ("the '752 patent"); United States Patent No. 6,314,754 ("the '754 patent"); and United States Patent No. 7,207,392 ("the '392

patent") (collectively referred to herein as "the patents-in-suit"), arising under 35 U.S.C. § 100, *et seq.*, and in particular § 271.

PARTIES

2. Firepass Holdings is a corporation organized and existing under the laws of the State of Delaware, with its address at P.O. Box 2021, New York, New York 10159, and is the owner and assignee of the '392 patent, the '754 patent, and the '752 patent.

3. Firepass is a corporation organized and existing under the laws of the State of Delaware, with its headquarters at 19 W. 21st Street, Suite 503, New York, New York 10010, and is the owner and assignee of the '065 patent.

4. Airbus Americas is a corporation organized and existing under the laws of the State of Delaware, with its principal office at 198 Van Buren St., Suite 300, Herndon, Virginia 20170.

5. Airbus Parent is a simplified joint stock company organized and existing under the laws of the State of France, with its principal office at 1, Rond Point Maurice Bellonte, 31707 Blagnac Cedex, France.

6. Parker is a corporation organized and existing under the laws of the State of Ohio, with its principal office at 6035 Parkland Blvd., Cleveland, Ohio 44124.

FACTUAL BACKGROUND

7. To ensure safety, the Federal Aviation Administration ("FAA") has issued rules to address the risk of fuel tank explosion by reducing the likelihood that fuel tank vapors will explode when an ignition source, such as a spark, occurs in the tank.

8. The FAA has observed that technology now exists that can prevent ignition of flammable fuel vapors by reducing their oxygen concentration below the level that will support combustion.

9. The FAA has determined that making vapors "inert," will significantly reduce the likelihood of such combustion.

10. To comply with FAA requirements, certain new passenger and cargo aircraft in operation manufactured after September 20, 2010 will be required to incorporate a flammability reduction means ("FRM").

11. According to the FAA, such new aircraft include the Airbus A318, A319, A320, A321, A330 and A340.

12. Certain operating aircraft will require a retrofit to incorporate an FRM.

13. According to the FAA, such retrofitted aircraft will include the Airbus A300, A310, A318, A319, A320, A321, A330 and A340.

14. As defined by the FAA, a fuel tank is considered inert when the bulk average oxygen concentration within each compartment of the tank is 12 percent or less from sea level up to 10,000 feet, then linearly increasing from 12 percent at 10,000 feet to 14.5 percent at 40,000 feet altitude, and extrapolated linearly above that altitude.

15. Parker has acknowledged its awareness of these FAA requirements in public documents, including that, certain passenger and cargo aircraft will be required to incorporate an FRM, such as a fuel tank inerting system.

16. According to Parker, its fuel tank inerting system uses air separation modules that generate nitrogen-enriched air by removing oxygen from its air source and distributing it to the aircraft's fuel tank, thereby reducing the flammability of fuel vapors in the tank.

17. Parker advertises that certain components of its fuel tank inerting system are provided by its division located within this judicial district.

18. Parker also advertises, including in this judicial district, that it makes, uses, offers to sell and sells fuel tank inerting systems.

19. Parker signed, in December 2006, a $500M contract (the "Airbus Contract") with Airbus Parent, Airbus Americas, or both, to supply fuel tank inerting systems in compliance with FAA regulations.

20. Pursuant to the Airbus Contract, Parker contracted to supply fuel tank inerting systems for certain Airbus aircraft models, including but not limited to, A300, A310, A318, A319, A320, A321, A330, A340 and A350 (the "Identified Aircraft").

21. The Airbus Contract obligates Parker's United States operations to deliver fuel tank inerting systems to Airbus in 2009.

22. Parker is taking steps to fulfill the Airbus Contract, for example, to meet its obligations under the Airbus Contract, including the 2009 delivery date, Parker claims that since 2006, it has operated five shifts instead of three to deliver the required systems to Airbus Parent.

23. Airbus claims that as of June 30, 2009, it has delivered to United States customers aircraft models A300, A310 A318, A319, A320, A321, A330, and A340 aircraft.

24. Airbus claims that as of June 30, 2009, it has orders from United States customers for aircraft models A300, A310 A318, A319, A320, A321, A330, A340 and A350.

25. Airbus claims that as of June 30, 2009, it has at least 170 Airbus aircraft orders from customers within this judicial district, 55 of which are pending delivery.

26. JetBlue, an Airbus customer headquartered within this judicial district, has taken delivery of at least 3 Airbus A320 aircraft in 2009, and will take deliver of 8 Airbus A320 aircraft in 2011, and 13 Airbus A320 aircraft in 2012.

27. Airbus claims that as of June 30, 2009, it has at least delivered 115 Airbus aircraft to customers within this judicial district.

28. Airbus claims that as of June 30, 2009, there exist for customers within this judicial district at least 100 Airbus aircraft in operation.

JURISDICTION AND VENUE

29. This Court has exclusive subject matter jurisdiction over this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

30. Venue is proper in this District under 28 U.S.C. §§ 1391 (b) and (c), and 1400(b).

31. This Court has personal jurisdiction over Parker. Parker regularly conducts and solicits business in the state of New York and derives substantial revenue from goods used or services rendered in the state of New York and in this judicial district, and expects or should reasonably expect its infringement of the patents-in-suit to have consequences in the state of New York, and Parker's infringement of the patents-in-suit has caused injury to Plaintiffs in the state of New York. Parker also derives substantial revenue from interstate or international commerce.

32. This Court has personal jurisdiction over Airbus Americas because it conducts business within the state of New York and in this judicial district, including contracting to supply to this district aircraft which incorporate and use the claimed inventions of the patents-in-suit, and has committed the tort of patent infringement in the State, and regularly derives substantial revenue from goods used in the State and within this judicial district, and expects or reasonably

expects its acts to have consequences in the State and this judicial district, and derives substantial revenue from interstate and international commerce.

33. This Court has personal jurisdiction over Airbus Parent because it conducts business within the state of New York and in this judicial district, including contracting to supply to this district aircraft which incorporate and use the claimed inventions of the patents-in-suit, and has committed the tort of patent infringement in the State, and regularly derives substantial revenue from goods used in the State and within this judicial district, and expects or reasonably expects its acts to have consequences in the State and this judicial district, and derives substantial revenue from interstate and international commerce.

THE PATENTS IN SUIT

34. The '315 patent, entitled "Hypoxic fire prevention and fire suppression systems for computer cabinets and fire-hazardous industrial containers," was duly and legally issued by the United States Patent and Trademark Office on January 1, 2002, after full and fair examination. The '315 patent was also duly and legally reissued by the United States Patent and Trademark Office on February 19, 2008, under the number RE 40,065. Copies of the RE 40,065 reissue patent and the '315 patent are annexed hereto as Exhibit A.

35. The '752 patent, entitled "Hypoxic fire prevention and fire suppression systems and breathable fire extinguishing compositions for human occupied environments," was duly and legally issued by the United States Patent and Trademark Office on July 16, 2002, after full and fair examination. A copy of the '752 patent is annexed hereto as Exhibit B.

36. The '754 patent, entitled "Hypoxic fire prevention and fire suppression systems for computer rooms and other human occupied facilities," was duly and legally issued by the United

States Patent and Trademark Office on November 13, 2001, after full and fair examination. A copy of the '754 patent is annexed hereto as Exhibit C.

37. The '392 patent, entitled "Method of preventing fire in computer room and other enclosed facilities," was duly and legally issued by the United States Patent and Trademark Office on April 24, 2007, after full and fair examination. A copy of the '392 patent is annexed hereto as Exhibit D.

COUNT 1 – PATENT INFRINGEMENT BY PARKER

38. The allegations of paragraphs 1 through 37 above are incorporated by reference as if fully set forth herein.

39. This cause of action for patent infringement arises under 35 U.S.C. § 271.

40. Parker, either directly or through its affiliates, subsidiaries and/or distributors, makes, uses, offers to sell, or sells without authority the claimed inventions of the patents-in-suit as incorporated in Identified Aircraft, and thus has infringed and is infringing, literally or under the doctrine of equivalents, one or more claims of the patents-in-suit.

41. Parker has infringed and is infringing the patents-in-suit by: (a) inducing infringement of one or more claims of the patents-in-suit; and (b) contributing to infringement of one or more claims of the patents-in-suit as incorporated in Identified Aircraft.

42. Parker supplies or has supplied in or from the United States all or a substantial portion of the components covered by the patents-in-suit as incorporated in Identified Airbus aircraft, where such components are uncombined in whole or in part, in such manner as to actively induce the combination of such components outside of the United States in a manner that would infringe the patents-in-suit if such combination occurred within the United States.

43. Parker's acts of infringement have been and continue to be willful, knowing and deliberate.

44. Plaintiffs first notified Parker of the '752 and '754 patents during a FirePass presentation on August 2004 at the offices of Parker Hannifin.

45. Two years later, Plaintiffs again notified Parker, this time in correspondence, of the '752 and '754 patents.

46. In the aforementioned correspondence, Plaintiffs emphasized to Parker the '752 and '754 patents' relevance to FAA regulations concerning fuel inerting systems that reduce oxygen levels in center wing fuel tanks.

47. Plaintiffs also notified Parker, in correspondence dated June 2007, of the '392, '315 and pre-reissue '315 patent (now RE 40,065), and their relevance to fuel inerting systems that reduce oxygen levels in center wing fuel tanks.

48. As a direct and proximate result of Parker's acts of infringement, Plaintiffs have been, are being, and will be damaged. Consequently, Plaintiffs are entitled to compensation for their damages from Parker pursuant to 35 U.S.C. § 284 in an amount that cannot presently be quantified, but will be ascertained at trial.

COUNT II – PATENT INFRINGEMENT BY AIRBUS

49. The allegations of paragraphs 1 through 48 above are incorporated by reference as if fully set forth herein.

50. This cause of action for patent infringement arises under 35 U.S.C. § 271.

51. Airbus, either directly or through its affiliates, subsidiaries and/or distributors, offers to sell, sells within the United States or imports into the United States without authority the claimed inventions of the patents-in-suit as incorporated in Identified Airbus aircraft, and thus

has infringed and is infringing, literally or under the doctrine of equivalents, one or more claims of the patents-in-suit.

52. Airbus has infringed and is infringing the patents-in-suit by (a) inducing infringement of one or more claims of the patents-in-suit; and (b) contributing to infringement of one or more claims of the patents-in-suit as incorporated in Identified Airbus aircraft.

53. As a direct and proximate result of Airbus' acts of infringement, Plaintiffs have been, are being, and will be damaged. Consequently, Plaintiffs are entitled to compensation for their damages from Airbus pursuant to 35 U.S.C. § 284 in an amount that cannot presently be quantified, but will be ascertained at trial.

54. As a direct and proximate result of Airbus' acts of infringement, Plaintiffs have been irreparably harmed and will continue to be harmed unless and until Airbus' infringing acts are enjoined and restrained by order of this Court.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs demand the following relief:

(i) A judgment declaring that Parker has infringed the patents-in-suit as alleged herein;

(ii) A judgment declaring that Airbus Americas has infringed the patents-in-suit as alleged herein;

(iii) A judgment declaring that Airbus Parent has infringed the patents-in-suit as alleged herein;

(iv) A judgment declaring that Parker has willfully infringed the patents-in-suit as alleged herein;

(v) A judgment and order awarding Plaintiffs damages under 35 U.S.C. § 284, including treble damages against Parker for willful infringement as provided by 35 U.S.C. § 284,

and supplemental damages for any continuing post-verdict infringement up until entry of the final judgment with an accounting as needed;

(vi) A judgment and order awarding Plaintiffs pre-judgment and post-judgment interest on the damages awarded;

(vii) A judgment and order declaring this to be an exceptional case and awarding Plaintiffs the costs of this action (including all disbursements) and attorneys' fees as provided by 35 U.S.C. § 285;

(viii) A judgment and order that Parker, Airbus Americas and Airbus Parent, their agents, employees, representatives, successors and assigns, and those acting in privity or in concert therewith, be permanently enjoined from further infringement of the patents-in-suit; and

(ix) Such other and further relief as the Court deems just and equitable.

DEMAND FOR JURY TRIAL

Plaintiffs demand a trial by jury.

Dated: October 1, 2009
New York, New York

Respectfully submitted,

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(19) United States
(12) Reissued Patent
Kotliar

(10) Patent Number: US RE40,065 E
(45) Date of Reissued Patent: Feb. 19, 2008

(54) HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS FOR COMPUTER CABINETS AND FIRE-HAZARDOUS INDUSTRIAL CONTAINERS

(75) Inventor: Igor K. Kotliar, New York, NY (US)

(73) Assignee: FirePASS Corporation, New York, NY (US)

(21) Appl. No.: 11/198,862

(22) Filed: Aug. 5, 2005

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: 6,334,315
Issued: Jan. 1, 2002
Appl. No.: 09/566,506
Filed: May 8, 2000

U.S. Applications:
(63) Continuation-in-part of application No. 09/551,026, filed on Apr. 17, 2000, now Pat. No. 6,314,754.

(51) Int. Cl.
F24F 3/16 (2006.01)

(52) U.S. Cl. 62/78; 95/47; 95/54; 169/54
(58) Field of Classification Search 62/78; 95/47, 54; 169/54
See application file for complete search history.

(56) References Cited

U.S. PATENT DOCUMENTS

3,948,626 A 4/1976 Bragg
4,378,920 A * 4/1983 Runnels et al. .... 244/135 R
4,556,180 A 12/1985 Manatt
4,681,602 A 7/1987 Glenn
4,896,514 A 1/1990 Sugiyama et al.
5,063,753 A 11/1991 Woodruff
5,220,799 A 6/1993 Lievens et al.
5,273,344 A 12/1993 Volkwein et al.
5,308,382 A 5/1994 Prasad
5,388,413 A 2/1995 Major et al.
5,472,480 A 12/1995 Barbe
5,649,995 A 7/1997 Gast, Jr.
5,730,780 A 3/1998 Booth, III
5,799,495 A 9/1998 Gast, Jr. et al.
5,799,652 A * 9/1998 Kotliar 128/205.11
5,921,091 A 7/1999 Foss et al.
6,012,533 A 1/2000 Cramer
6,112,822 A 9/2000 Robin et al.
6,547,188 B2 4/2003 Schmutz et al.
6,604,558 B2 8/2003 Sauer
6,634,598 B2 10/2003 Susko
6,729,359 B2 5/2004 Jones
6,739,359 B2 5/2004 Jones et al.
6,739,400 B2 5/2004 Lessi et al.

OTHER PUBLICATIONS

William M. Cavage, Federal Aviation Administration, Atlantic City, NJ, and Timothy Bowman, Boeing Phantom Works, St. Louis, MO, *Modeling In-flight Inert Gas Distribution in a 747 Center Wing Fuel Tank*, AIAAFDC32143b.pdf, 598 Kb, 13 pages, FAA White Papers.
William M. Cavage, Fire Safety Branch, Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City International Airport, NJ, *Modeling of In-flight Fuel Tank Inerting for FAA OBIGGS Research*, 255 Kb, 11 pages, FAA White Papers.

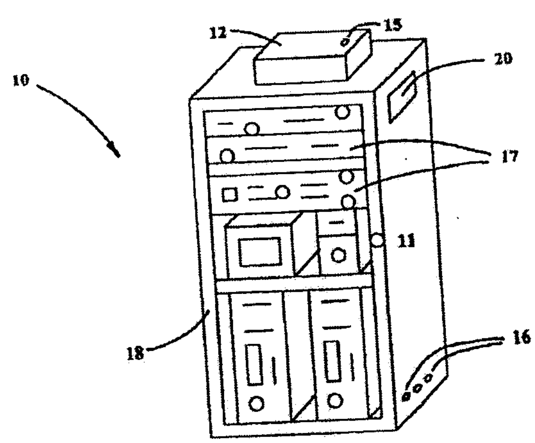
(Continued)

Primary Examiner—William C. Doerrler

(57) ABSTRACT

Fire prevention and suppression system is provided for computer cabinets and fire-hazardous containers. The equipment of the system provides low-oxygen environments at standard atmospheric pressure. The system employs an oxygen-extraction apparatus that supplies oxygen-depleted air inside an enclosed area communicating with the device. A fire-extinguishing composition is provided for continuous use in computer cabinets and fire-hazardous containers, consisting of oxygen-depleted air having oxygen content below 12%.

26 Claims, 3 Drawing Sheets



OTHER PUBLICATIONS

William M. Cavage and Robert Morrison, Fire Safety Branch, Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City Int'l Airport, NJ, *Development and Testing of the FAA Simplified Fuel Tank Inerting System*, Cavage–FAAOBIGGSDevelop&Test, 530 Kb, 11 pages, FAA White Papers.

Steven M. Summer, *Limiting Oxygen Concentration Required to Inert Jet Fuel Vapors Existing at Reduced Fuel Tank Pressures*, Aug. 2003, DOT/FAA/AR–TN02/79, 1.8 Mb, 32 pages, FAA White Papers.

William M. Cavage, Fire Safety Branch, Federal Aviation Administration, AAR–422, Building 204, William J. Hughes Technical Center, Atlantic City International Airport, NJ, *Ground–Based Inerting of Commercial Transport Aircraft Fuel Tanks*, RTO_AVT–GBI Paper 761 Kb, 20 pages, FAA White Papers.

William M. Cavage, Fire Safety Section, Federal Aviation Administration, Atlantic City International Airport, NJ, *Modeling Inert Gas Distribution in Commercial Transport Aircraft Fuel Tanks*, AIAA Paper 2002–3032, Report 1300, 600 Kb pages, FAA White Papers.

Charles C. Graves and Donald W. Bahr, FAA–Propulsion Chemistry Division, *Basic Considerations in the Combustion of Hydrocarbon Fuels with Air*, NACA –1300, 24.04 Mb 26, 267 pages, FAA White Papers.

William M. Cavage, FAA, AAR–422, Fire Safety R&D, Copyright @ 2001 Society of Automotive Engineers, Inc., *Ground–Based Inerting of a Boeing 737 Center Wing Fuel Tank*, SAE–GBI, 281 Kb, 8 pages, FAA White Papers.

Michael Burns, William M. Cavage, Federal Aviation Administration, William J. Hughes Technical Center, Airport and Aircraft Safety, Research And Development Division, Atlantic City Int'l Airport, NJ 08405, *Ground and Flight Testing of a Boeing 737 Center Wing Fuel Tank Inerted With Nitrogen–Enriched Air* DOT/FAA/AR–01/63, 4.91 Mb, 34 pages, FAA White Papers.

Samuel V. Zinn, Jr., Nat'l Aviation Facilities Experimental Center, Atlantic City, NJ, *Inerted Fuel Tank Oxygen Concentration Requirements*, Aug. 1971, FAA–RD–71–42 1.58 Mb, 23 pages, FAA White Papers.

Thomas L. Reynolds, et al., Boeing Commercial Airplanes Group, Seattle, Wash., *Onboard Inert Gas Generation System/Onboard Oxygen Gas Generation System*, May 2001, (OBIGGS/OBOGS) Study NASA/CR–2001–210903 7.75 Mb, 179 pages, FAA White Papers.

Michael Burns and William M. Cavage, Federal Aviation Administration, FAA William J. Hughes Technical Center, Airport and Aircraft Safety, Research and Development Division, Atlantic City Int'l. Airport, NJ, *Inerting of a Vented Aircraft Fuel Tank Test Article With Nitrogen Enriched Air*, Apr. 2001, 2.28 Mb., 29 pages, FAA White Papers.

Steven M. Summer, *Cold Ambient Temperature Effects on Heated Fuel Tank Vapor Concentrations*, Jul. 2000, DOT/FAA/AR–TN99–93, 395 Kb, 13 pages, FAA White Papers.

William M. Cavage, Airport and Aircraft Safety, Research and Development Division, FAA William J. Hughes Technical Center, Atlantic City International Airport, NJ, May 2000, *The Cost of Implementing Ground–Based Fuel Tank Inerting in the Commercial Fleet*, DOT/FAA/AR–00/19,941 Kb, 60 pages, FAA White Papers.

A Benefit Analysis for Nitrogen Inerting of Aircraft Fuel Tanks Against Ground Fire Explosion, Dec. 1999, Final Report, DOT/FAA/AR–99/73 Office of Aviation Research, NTIS, Springfield, VA, 617 Kb, 117 pages.

Steveb M. Summers, *Mass Loading Effects on Fuel Vapor Concentrations in an Aircraft Fuel Tank Ullage*, Sep. 1999, DOT/FAA/AR–TN99/65, 934 Kb, 14 pages.

A Review of the Flammability Hazard of Jet A Fuel Vapor in Civil Transport Aircraft Tanks, Jun. 1998, Final Report, DOT/FAA/AR–98/26, 1.04 Mb, 62 pages, FAA White Papers.

Aircraft Accident Report, *In–Flight Breakup Over the Atlantic Ocean Trans World Airlines Flight 800*, National Transportation Safety Board, NTSB/AAR–00/03 7.63 Mb, 341 pages.

Daniel R. Bower, Ph.D., *Flight Test Group Chairman's Factual Report of Investigation*, Jul. 17, 1996, NTSB/SA–516, 96 Kb, 24 pages, FAA White Papers.

Ivor Thomas, *FAA R&D Efforts on Flammability*, Aug. 14, 2002, 2.3 Mb, 27 pages, FAA White Papers.

Alan Levin, *Lower cost, higher risk helped alter FAA stance*, (McLean, VA: Feb. 17, 2004. p. A.03), Copyright 2004 Gannett Company, Inc., USA Today.

Alan Levin, *FAA Suggests Airbus Modify Jets to Reduce Risks; Fuel Tanks Scrutinized*, (McLean VA: Nov. 19, 2003 p. B.03), Final Edition, Copyright 2003 Gannett Company, Inc., USA Today.

Alan Levin, *Jets Must Be Altered, Device Created to Stop Fuel–Tank Explosions*(McLean VA: Feb. 17, 2004, p. A.01), Final Edition, Copyright 2004 Gannett Company, Inc., USA Today.

Alan Levin, *FAA Device Could Guard Against Terrorism; Experts: Fuel–tank System Could Help Jets Survive Missle Attack* (McLean Va: Feb. 18, 2004, p. A.03) Final Edition, Copyright 2003 Gannett Company, Inc., USA Today.

David Evans, *Safety v. Entertainment*, (Feb. 1, 2003) Avionics Magazine.

Peg Hashem, *Hamilton Sundstrand and Two Units of Cobham to Supply Nitrogen Generation System for Boeing 7E7*, Hamilton Sundstrand, A United Technologies Company, Windsor Locks, Conn., Corporate Press Release (Jul. 1, 2004).

Andrew J. Peacock, *Oxygen at High Altitude*, BMJ 1998; 317:1063–1066 (Oct. 17).

Peter W. Hochachka, *Mechanism and Evolution of Hypoxia–Tolerance in Humans*, The Journal of Experimental Biology 201, 1243–1254 (1998).

J. Hardy Tyson and John F. Barnes, *The Effectiveness Of Ullage Nitrogen–Inerting System Against 30–mm High–Explosive Incendiary Projectiles*, Naval Weapons Center, China Lake, CA, Report JTCG/AS–90–T–004, (May 1991).

* cited by examiner

Fig. 1

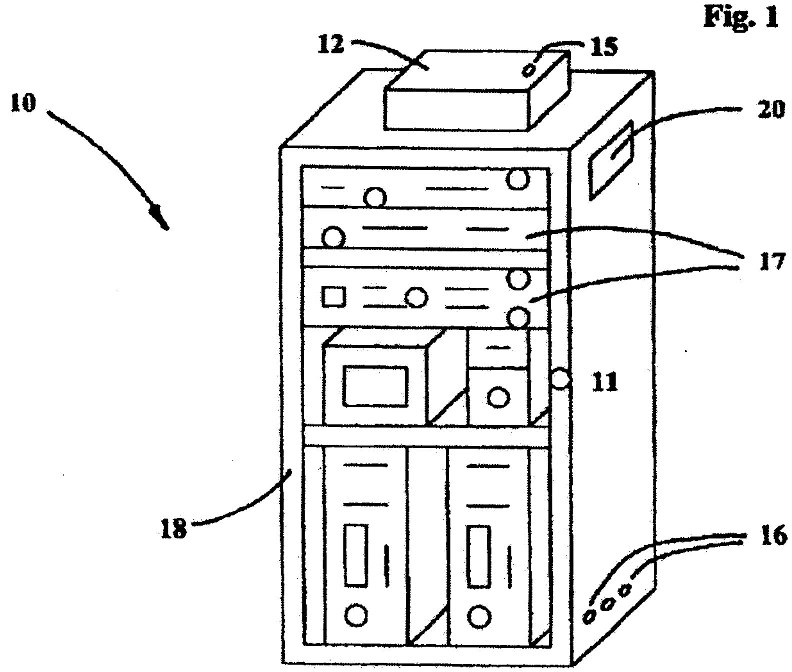


Fig. 2

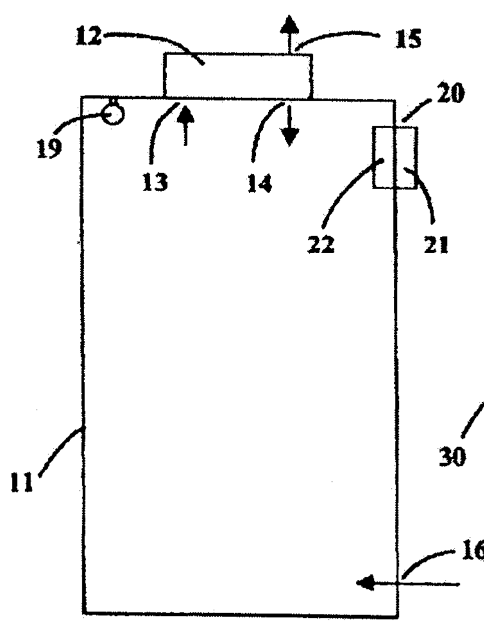


Fig. 3

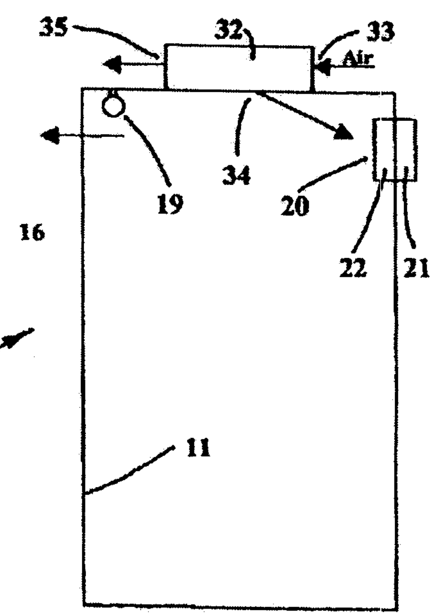


Fig. 4

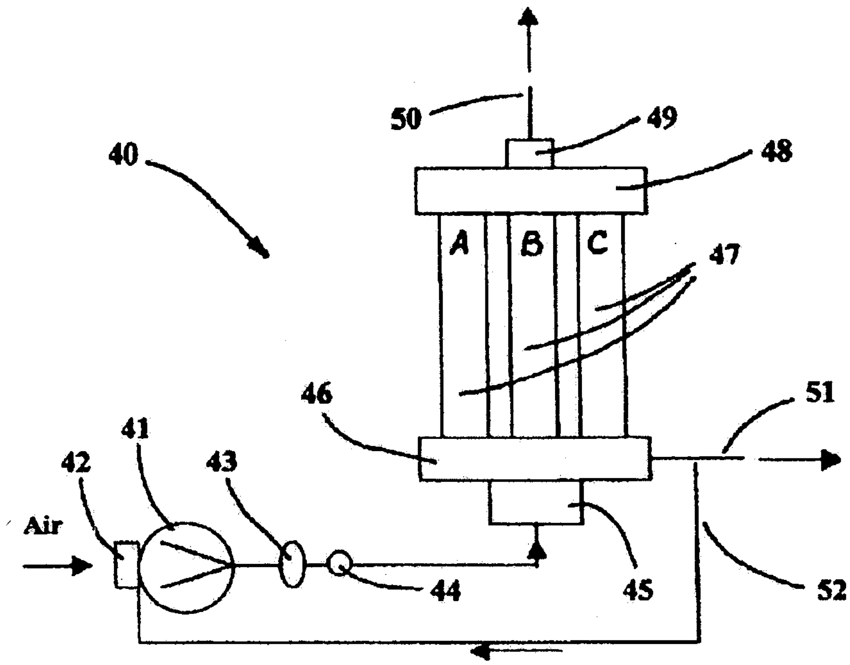


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Fig. 5

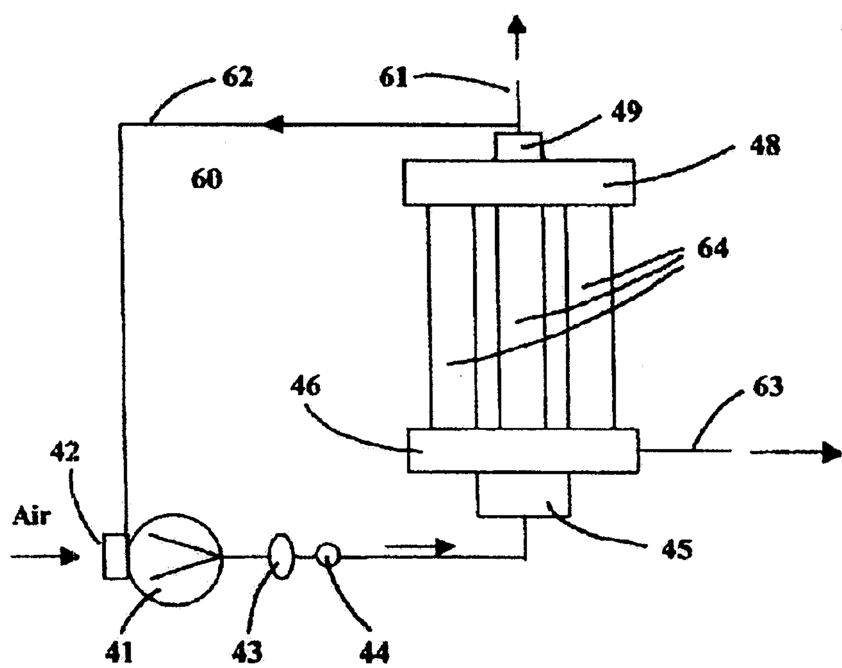

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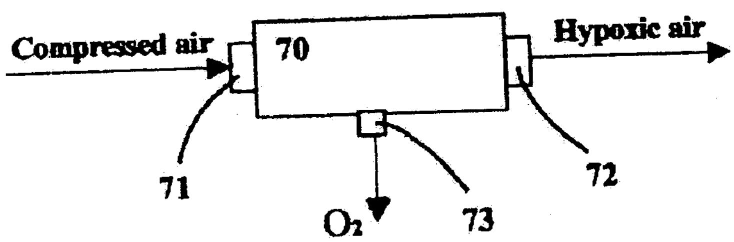
Fig. 6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Hypoxic air
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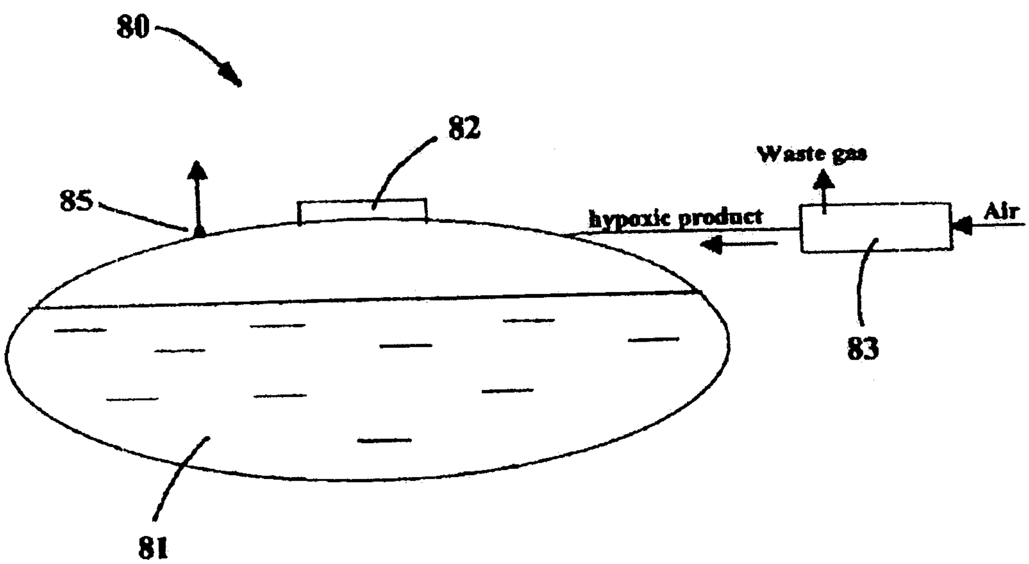
Fig. 7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Waste gas
hypoxic product
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HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS FOR COMPUTER CABINETS AND FIRE-HAZARDOUS INDUSTRIAL CONTAINERS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED APPLICATIONS

This invention is related to preceding U.S. Pat. No. 5,799,652 issued Sept. 1, 1998, U.S. Pat. No. 5,887,439 issued Mar. 30, 1999, U.S. Pat. No. 5,924,419 of Jul. 20, 1999 and is continuation in part of the U.S. patent application Ser. No. 09/551,026 filed on Apr. 17, 2000.

FIELD OF THE INVENTION

The present invention relates to a process and equipment for providing low-oxygen (hypoxic) environments inside a computer cabinet or container with combustible or explosive material in order to prevent or suppress fire before it starts.

The demand in reliable fire prevention and suppression systems for industrial applications has been always very high and is growing extensively, especially with the explosive development of Internet, computerized equipment and communication systems. The invented Fire Prevention And Suppression System can be used in any possible application where a non-occupied environment requires protection from fire hazard or explosion.

DESCRIPTION OF THE PRIOR ART

At the present time there are no products on the market that would allow to prevent fire from igniting inside computer cabinets or other industrial enclosures containing inflammable or explosive materials. A computer or server produces a lot of heat inside its enclosure or cabinet, mainly due to friction and overheating of electronic components. At any time a malfunction of an electronic component or short circuit may cause fire and extensive damage. A spark inside a fuel container at gas station or tanker may cause immediate explosion. All current fire prevention and suppression systems are design in order to suppress fire after its starts, which might be too late. Current fire suppression systems are destructive for computerized equipment and cannot guarantee that fire will not start.

There are millions of powerful computers around the world, owned by large corporations, banks, communication companies, military and government agencies, many of them loosing millions of dollars in just one such fire.

There is no prior art on fire protection systems build inside a computer cabinet or fire hazardous container. The process and equipment described in this invention can guarantee that no fire will be able to start inside such computer cabinet or container having internal atmosphere with oxygen content under 10%.

The invention described in this document will prevent huge financial and environmental losses from industrial fires and will save many lives of fire fighters and general public.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide a method for producing a fire safe hypoxic environment inside a computer cabinet or container with combustible, inflammable or explosive materials.

Further object of the present invention is the provision of an oxygen-depletion process and an apparatus for producing a low-oxygen environment inside a computer cabinet or industrial container, such equipment employing molecular-sieve adsorption or membrane-separation technologies.

A still further object of the invention is to provide a fire-retarding oxygen-depleted environment inside a computer room or industrial facility at standard, slightly reduced or increased atmospheric pressure and having oxygen content fewer than 10%.

Another object of this invention is to establish fire safe hypoxic environments inside computer cabinets or containers with combustible, inflammable or explosive materials by providing constant ventilation of such enclosures with oxygen-depleted air in order to remove heat and/or explosive fumes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the most preferred embodiment of the fire safe computer cabinet.

FIG. 2 illustrates schematically a working principle of the invented hypoxic fire prevention and suppression system employing hypoxic generator in extraction mode.

FIG. 3 illustrates schematically an alternative working principle of the invented hypoxic fire prevention and suppression system employing hypoxic generator in supply mode.

FIG. 4 presents a schematic view of a working principle of hypoxic generator employing nitrogen adsorbing molecular-sieve material and Pressure-swing adsorption technology.

FIG. 5 presents a schematic view of a working principle of hypoxic generator employing oxygen adsorbing molecular-sieve material and Pressure-swing adsorption technology.

FIG. 6 shows schematically working principle of hypoxic generator employing Membrane air-separation technology.

FIG. 7 illustrates a schematic view of an industrial container filled with highly inflammable fluid.

DESCRIPTION OF THE INVENTION

It is well known that combustion process requires oxygen, therefore the goal of this invention is to provide an extreme hypoxic normbaric environment inside a computer cabinet or any container in order to eliminate fire hazard completely.

This invention is based on a discovery made by the inventor during research with the Hypoxic Room System made by Hypoxico Inc. in New York. It was discovered that a normbaric hypoxic environment provides a different effect on ignition and combustion process than hypobaric or natural altitude environments with the same partial pressure of oxygen. For example, gasoline or any gas lighter would ignite and bum on an altitude of 19,000' (5,800 m) in the air having partial pressure of oxygen at 2.99" (76 mm) of mercury.

However, if we create a corresponding normbaric hypoxic environment with the same partial pressure of oxygen at 2.99" or 76 mm of mercury, we will find that gasoline will not burn or even ignite. Any attempt to ignite it would fail because even a gaslighter or gas torch would not ignite in this environment. It means that normbaric environments with corresponding oxygen content of 10% are absolutely safe against any fire hazard.

This invention provides reliable and inexpensive process and equipment for producing such fire-retarding environ-

ment inside a computer cabinet or container with fire hazardous material.

FIG. 1 shows the most preferred embodiment of the fire safe computer cabinet system 10 consisting of cabinet enclosure 11 having (in this case clear) door 18 and air intake openings 16 and filled with computer equipment or components 17, further having hypoxic generator 12 mounted on the top of the cabinet enclosure 11.

FIG. 2 shows schematically a working principle of the invented hypoxic fire prevention and suppression system 10 employing hypoxic generator in extraction mode.

The fire safe computer cabinet system 10 consists of a computer rack or cabinet enclosure 11 filled with computer devices or components and hypoxic generator 12 mounted directly on cabinet enclosure 11 and having air intake 13 and outlets 14 and 15. Computer cabinet 11 does not have to be absolutely airtight—it has multiple openings or holes 16, preferably in its lower portion. Openings 16 are shown schematically for better understanding of air circulation inside cabinet 11. In reality there is no need for special openings because air will always be able to enter cabinet through gaps around the door or through semi-airtight enclosure.

Hypoxic generator 12 draws air from the cabinet 11 through the intake 13 and extracts a part of oxygen from it allowing oxygen depleted air back into cabinet 11 through outlet 14. Oxygen-enriched gas mixture is disposed into atmosphere through disposal outlet 15. This process creates a slightly negative pressure inside cabinet 11 that works as a driving force for intaking fresh air through the openings 16, in order to equalize atmospheric pressures inside and outside of cabinet 11. Therefore semi-airtight cabinet 11 and even holes 16 in it are absolutely necessary functional components of this fire-retarding system.

Hypoxic generator starts working when door 18 is closed. At the beginning, the oxygen-enriched gas being removed from the system through disposal outlet 15 has a little higher oxygen content (about 30%) than ambient air entering cabinet 11 through holes 16 (20.94% at sea level). It means that oxygen content inside cabinet 11 will start dropping to a certain level below 10%. At the same time the oxygen content in the disposal fraction will also decrease to about ambient air level. The higher oxygen content in the disposal fraction, the lower will be the oxygen content inside cabinet 11. The lowest possible oxygen content inside cabinet 11 will be about 4.5%. Most important in the invented system is that it does not affect air composition in the room where the system 10 is installed. After oxygen content in cabinet 11 drops to desired level, the system 10 becomes balanced and will extract composition with oxygen content close to ambient air.

When oxygen content inside cabinet 11 drops below 7%, which will be detected by oxygen transducer 19 installed inside cabinet 11, hypoxic generator 12 turns off in order to save energy. When, after some time, oxygen content inside cabinet 11 reaches about 12%, transducer 19 will turn on hypoxic generator 12 again, and so further in cycles. Expensive oxygen transducer 19 is optional and can be replaced by a simple timer, which can turn on and off hypoxic generator 12 in preset intervals of time.

An air-cooling device 20 is installed in order to reduce temperature inside cabinet 11. The device 20 consists of thermoelectric module having cold sink plate 22 inside cabinet 11 and heat sink 21 outside cabinet 11. Big advantage of thermoelectric modules is the absence of refrigerant or any moving parts. Working principle of a thermoelectric

cooler is well known and such devices are available on the market. Suitable device with high-performance thermoelectric module and high-fin-density cold sink and heat sink can be bought from TE Technology Inc. in Michigan, U.S.A.

It is advisable to direct the gas flow from outlet 14 against the cold sink 22 of the cooler 20 in order to provide better circulation of cold gas mixture inside cabinet 11 and better cooling of electronic components 17. Cooler 20 can be equipped with a simple thermostat that will control temperature inside cabinet 11 and save energy by turning off the cooler 20 when desired low temperature is reached.

FIG. 3 illustrates schematically an alternative working principle of the invented hypoxic fire prevention and suppression system 30 employing hypoxic generator 32 in supply mode. This embodiment does not change anything in design of cabinet 11 and all other components. The only difference is in configuration of hypoxic generator 32 that is the same as generator 12, but connected different way to cabinet 11.

Hypoxic generator 32 takes in ambient air through intake 33 and separates it into oxygen-depleted fraction being transmitted inside cabinet 11 through outlet 34 and oxygen-enriched fraction being disposed into atmosphere through disposal outlet 35. This way cabinet 11 becomes constantly ventilated with low-oxygen gas mixture. Hypoxic generator shown below on FIG. 4 will be available in 2001 from Hypoxico Inc. in New York. It can provide oxygen-depleted air with any oxygen concentration in the range from 5% to 10%, which can be exactly preset at the factory.

The oxygen-depleted air entering cabinet 11 through outlet 34 is directed against cold sink 22 of the thermoelectric cooler 20 and sinks further down to the bottom of cabinet 11. In this embodiment openings 16 are moved to the higher position in order to exhaust warm gas mixture instead of cool one at the bottom of cabinet. This way, an effective air circulation inside cabinet 11 is assured, providing better cooling of computer components 17. The invented system 30 is entirely safe because disposal fraction having only slightly increased oxygen content of about 30% is instantly dissociated in the surrounding atmosphere. The system 30 does not affect air composition in surrounding atmosphere in any way because the oxygen amount in both fractions exiting the system is equivalent to the amount of oxygen in the air entering the system. Constant ventilation of the internal environment allows to remove heat from cabinet 11. This embodiment is most suitable for fire-hazardous containers because constant ventilation will allow removing of explosive fumes.

All parts of the systems 10 and 30 are shown schematically, in order to provide better understanding of the working principle. For instance, thermoelectric cooler 20 could be build in the air supply line before outlet 14 or 34, or hypoxic generator could be a free-standing unit connected with cabinet 11 through air conduits. Computer rack enclosure 11 can be computer cabinet or container with fire-hazardous materials. Transducer or timer 19 and cooler 20 are optional in some applications.

Other oxygen-extraction devices employing molecular-sieve adsorption, membrane-separation or other technologies can be used instead on hypoxic generator 12 or 32 in the invented system. However, it is highly recommended to use reliable hypoxic generators specially designed by Hypoxico Inc. in New York.

FIG. 4 presents a schematic view of a working principle of hypoxic generator HYP-10/PSA/Z employing Pressure-swing adsorption technology, which will be available from

Hypoxico Inc. in New York in 2001. This hypoxic generator 40 produces about 10 liters per minute of hypoxic air with preset oxygen content in the product between 5% and 10%. Miniature hypoxic generators producing 0.5 to 5 liters per minute will be available for smaller cabinets as well. All these generators employ molecular-sieve materials, mainly synthetic zeolites that adsorb nitrogen and allow oxygen to pass through the adsorbing material.

Compressor **41** draws ambient air through intake filter **42** and pressurizes it to about 15 psi or 1 bar. Further compressed air is chilled in air cooler **43** and transmitted through high-efficiency air filter **44** into distribution valve **45** mounted on manifold **46**.

3 elongated containers **47** with molecular sieve material are mounted on manifold **46** the way that pressurized air is selectively and in cycles delivered into each container **47** allowing to pressurize them for several seconds at about 15 psi or 1 bar. Number of containers **47** may vary from 1 to 12 or more and they can be pressurized individually or in groups. On the other end all containers are interconnected with a collecting tank **48** having release valve **49**.

Under pressure molecular sieve material in containers **47** allows oxygen-enriched fraction to pass through into tank **48**, adsorbing remaining air gases, including mostly nitrogen and water vapors. Oxygen-enriched fraction is disposed into atmosphere through release valve **49** and disposal outlet **50**. Distribution valve **45** continuously in cycling manner redirects the flow of compressed air from one container to two others. After several seconds of pressurization the molecular sieve material in container A becomes saturated with nitrogen-enriched fraction. At this time distribution valve **45** takes first position by opening container A for depressurization and redirects the flow of compressed air into containers B and C.

The nitrogen-enriched fraction from container A is transmitted inside manifold **46** into product outlet **51** having recycling loop **52**. Part of nitrogen-rich product is transmitted through recycling loop **52** back into compressor intake **42**. This allows significantly increasing efficiency of the hypoxic generator **40** without increasing working pressure, power consumption and weight. Low working pressure allows extending compressor life up to 5 years or more without any maintenance. Recycling loop **52** is only active for generators in supply mode as shown in embodiment **30** and is closed in generators working in extraction mode as shown on FIG. **2**.

During the depressurization cycle of container A, a small amount of oxygen-enriched fraction being kept in tank **48** under minimal pressure by valve **49** is released back into container A, purging it from contaminating nitrogen.

Second position of distribution valve **45** sets containers C and A under pressure, depressurizing container B and transmitting its content into product outlet **51**.

Third and last position of distribution valve **45** opens container C for depressurization and directs compressed air into containers A and B.

There is large selection of suitable distribution valves available on the market: from mechanical and electric to solenoid and air-piloted, both linear and rotary types. For this reason, working principles of these devices will be not explained in this work further. It is not difficult for those skilled in the art to find suitable valve and manifold for any number of containers **47** or their groups.

FIG. **5** presents a schematic view of an alternative working principle of hypoxic generator **60** employing the same Pressure-swing adsorption technology, but different adsorbent that adsorbs oxygen and allows nitrogen to pass through the adsorbing material. Carbon molecular-sieve material (CMSO2) has tiny hollow traps in its porous structure called "bottlenecks" that allow oxygen molecules to get in under pressure. Most of oxygen molecules being "trapped" inside such "bottlenecks" cannot find their way out in their chaotic movements. This technology is well known to those skilled in the art and is used in nitrogen generators.

Most of the components of the generator **60** are the same as in embodiment **40** and their working principle will not be described again. The only difference in this embodiment is that product and disposal outlets replace each other.

Compressed air pressurizes selectively containers **64** with oxygen adsorbing molecular-sieve material that allows nitrogen-enriched fraction to pass through into product outlet **61** via collecting tank **48** and release valve **49**. A part of the product is returned back into system **60** through recycling conduit **62**. Oxygen-enriched adsorbat is released into atmosphere through disposal outlet **63**.

Hypoxic generators **12** and **32** may also employ oxygen-enrichment membrane **70** that is schematically shown on FIG. **6**. Usually such membranes are made as elongated container filled with synthetic hollow fibers that permit oxygen under pressure through their walls and allow nitrogen-enriched fraction to pass through the hollow fibers.

Compressed air enters membrane **70** through inlet **71** and is separated there into oxygen-enriched permeate being disposed through outlet **73** and hypoxic product delivered via product release valve **72**.

FIG. **7** shows another embodiment **80** of the invented Fire Prevention and Suppression System. A fire-hazardous industrial container **81** contains highly inflammable liquid (alcohol, acetone, gasoline, kerosene, liquid gas, paint, etc.) or dry fire-hazardous and explosive materials. Container **81** can be any industrial container, including stationary and mobile fuel tanks, sea tankers and cargo ships, underground fuel tanks at gas stations, dip and quench tanks, spray and coatings containers, spill containment dikes, storage enclosures and cabinets and other containers with fire hazardous materials and compositions.

Hypoxic generator **83** can be installed directly on container **81** like shown in embodiments **10** and **30** or at remote location, as shown on FIG. **7**. It is advisable for such cases to use hypoxic generator in supply mode as shown in embodiment **30**.

Hypoxic generator **83** supplies oxygen-depleted air into tank **81** having a hatch or entry **82** and/or vent **85**. Heavy nitrogen rich product covers surface of the inflammable liquid and fills the rest of the container **81** replacing explosive vapors being expelled from container **81** through vent **85** or ventilation hole in hatch **82**. Waste gas containing enriched-oxygen fraction is disposed from generator **83** into atmosphere.

Such fire-retarding environment can be kept inside tank **81** permanently by supplying nitrogen rich product in necessary intervals—after fire safe environment with the lowest oxygen content is established, generator **83** can be shut down and turned on again by a timing device.

The invented technology should be applied for ventilating underground communication tunnels, mining facilities, munitions and missile bunkers, underground military installations and other facilities in order to remove explosive gases and replace them with fire safe hypoxic air.

What is claimed is:

1. A system for providing a fire-extinguishing atmosphere in enclosed environments, said system comprising:

an industrial container containing a fire-hazardous material;

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below 12%, *but greater than 9%, wherein said enclosed environment comprises said industrial container and said first outlet is coupled to said industrial container*;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing a molecular-sieve adsorber and said intake being operatively associated with a distribution valve providing distribution of said intake gas to multiple inlets each communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs nitrogen and water vapors and allows said enriched-oxygen gas mixture to pass through into collecting tank communicating with said second outlet;

said collecting tank being operatively associated with all said separation containers and receiving selectively said enriched-oxygen gas mixture therefrom;

said separation containers being selectively pressurized and depressurized in cycles and releasing during each depressurization cycle said reduced-oxygen gas mixture being delivered into said first outlet;

said second outlet having release valve allowing to keep said enriched-oxygen gas mixture being collected in said collecting tank under increased atmospheric pressure, so when any of said separation containers depressurizes, a portion of said enriched-oxygen gas mixture is released from said tank back into said container purging said molecular sieve material from remaining nitrogen and water.

2. A system for producing a fire-extinguishing atmosphere in enclosed environments, said system comprising:

an industrial container containing a fire-hazardous material;

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below

12%, *but greater than 9%, wherein said enclosed environment comprises said industrial container and said first outlet is coupled to said industrial container*;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing a molecular-sieve adsorber and said intake being operatively associated with a distribution valve providing distribution of said intake gas to multiple inlets each communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs oxygen and allows said reduced-oxygen gas mixture to pass through into collecting tank communicating with said first outlet;

said collecting tank being operatively associated with all said separation containers and receiving selectively said reduced-oxygen gas mixture therefrom;

said separation containers being selectively pressurized and depressurized in cycles and releasing during each depressurization cycle said enriched-oxygen gas mixture being delivered into said second outlet.

3. The apparatus according to claim 1 and

said distribution valve being air distribution device selected from the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

said distribution valve being communicating with and mounted on manifold that is selectively communicating with said multiple separation containers and said first outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said reduced-oxygen gas mixture therefrom.

4. The apparatus according to claim 2 and

said distribution valve being air distribution device selected from the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

said distribution valve being communicating with and mounted on manifold that is selectively communicating with said multiple separation containers and said second outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said enriched-oxygen gas mixture therefrom.

5. An apparatus for producing a fire-extinguishing atmosphere in enclosed environments, said apparatus comprising:

an industrial container containing fire-hazardous material;

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below 12%, *but greater than 9%, wherein said enclosed environment comprises said industrial container and said first outlet is coupled to said industrial container*;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing [a membrane] *an* air separator *membrane* for separating said intake gas into said reduced-oxygen and enriched-oxygen gas mixtures.

6. The system of claim 2 wherein said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content of between 10% and 12%.

7. The system of claim 1 wherein said industrial container further comprises a fuel tank.

8. The system of claim 7 wherein said fuel tank further comprises a mobile fuel tank.

9. The system of claim 2 wherein said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content of between 10% and 12%.

10. The system of claim 2 wherein said industrial container further comprises a fuel tank.

11. The system of claim 10 wherein said fuel tank further comprises a mobile fuel tank.

12. The system of claim 5 wherein said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content of between 10% and 12%.

13. The system of claim 5 wherein said industrial container further comprises a fuel tank.

14. The system of claim 13 wherein said fuel tank further comprises a mobile fuel tank.

15. A method for providing a fire-extinguishing atmosphere in enclosed environments, comprising:

providing a cabinet containing electronic components;

providing a compressor having an inlet and a compressed gas outlet;

providing an air separation device having an intake and first and second outlets, operatively associating said intake and compressed gas outlet and receiving an intake gas under pressure from said compressor;

coupling said first outlet to said cabinet;

emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and emitting an enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

providing a fire-retarding gas mixture for said enclosed environments in said cabinet with oxygen content below 12%, but greater than 9%;

releasing said enriched-oxygen gas mixture into said outside atmosphere;

employing a molecular-sieve adsorber and a collecting tank and operatively associating said intake with a distribution valve and distributing said intake gas to multiple inlets, each inlet communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs nitrogen and water vapors and allows said enriched-oxygen gas mixture to pass through into said collecting tank communicating with said second outlet;

operatively associating said collecting tank with all said separation containers and receiving selectively said enriched-oxygen gas mixture therefrom;

selectively pressurizing and depressurizing said separation containers in cycles and releasing during each depressurization cycle said reduced-oxygen gas mixture being delivered into said first outlet;

collecting said enriched-oxygen gas mixture in said collecting tank under increased atmospheric pressure, so when any of said separation containers depressurizes, a portion of said enriched-oxygen gas mixture is released from said tank back into said container purging said molecular sieve material from remaining nitrogen and water.

16. A method for producing a fire-extinguishing atmosphere in enclosed environments, comprising:

providing a cabinet containing electronic components;

providing a compressor having an inlet and a compressed gas outlet;

providing an air separation device having an intake and first and second outlets, operatively associating said intake with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

coupling said first outlet to said cabinet;

emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and emitting an enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments in said cabinet with oxygen content below 12%, but greater than 9%;

releasing said enriched-oxygen gas mixture through said second outlet into said outside atmosphere;

employing a molecular-sieve adsorber and a collecting tank and operatively associating said intake with a distribution valve and distributing said intake gas to multiple inlets, each inlet communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs oxygen and allows said reduced-oxygen gas mixture to pass through into said collecting tank communicating with said first outlet;

operatively associating said collecting tank with all said separation containers and receiving selectively said reduced-oxygen gas mixture therefrom;

selectively pressurizing and depressurizing in cycles and releasing during each depressurization cycle said enriched-oxygen gas mixture being delivered into said second outlet.

17. The method according to claim 15 and further comprising:

providing said distribution valve from among one of the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer; and

communicating said distribution valve with and mounted on a manifold that is selectively communicating with said multiple separation containers and said first outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said reduced-oxygen gas mixture therefrom.

18. The method according to claim 16 and further comprising:

providing said distribution valve from among one of the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

communicating said distribution valve with and mounted on a manifold that is selectively communicating with said multiple separation containers and said second outlet, and selectively allowing periodic access of

pressurized air inside said containers and exit of said enriched-oxygen gas mixture therefrom.

19. The method of claim 16 further comprising providing a fire-retarding gas mixture for said enclosed environments with an oxygen content of between 10% and 12%.

20. The method of claim 16 wherein providing said electronic components further comprises providing computer equipment.

21. The method of claim 16 wherein providing a fire-retarding gas mixture for said enclosed environments further comprises providing an oxygen content of between 10% and 12%.

22. The method of claim 15 wherein providing said electronic components further comprises providing computer equipment.

23. A method for producing a fire-extinguishing atmosphere in enclosed environments, comprising:

providing an industrial container containing fire-hazardous material;

providing a compressor having an inlet and a compressed gas outlet;

providing an air separation device having an intake and first and second outlets, operatively associating said intake with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

coupling said first outlet to said industrial container;

emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said received intake gas through said first outlet and emitting an enriched-oxygen gas mixture having a greater concentration of oxygen than said received intake gas through said second outlet;

providing a fire-retarding gas mixture at said first outlet to said industrial container with an oxygen content below 12%, but greater than 9%;

selectively communicating said second outlet with said outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere; and

employing an air separator membrane in said air separation device for separating said intake gas into said reduced-oxygen and enriched-oxygen gas mixtures.

24. The method of claim 26 further comprising providing said fire-retarding gas mixture with an oxygen content of between 10% and 12%.

25. The method of claim 23 wherein providing said industrial container further comprises providing a fuel tank.

26. The method of claim 25 wherein providing said fuel tank further comprises providing a mobile fuel tank.

* * * * *

US006334315B1

(12) **United States Patent**
Kotliar

(10) Patent No.: **US 6,334,315 B1**
(45) Date of Patent: **Jan. 1, 2002**

(54) **HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS FOR COMPUTER CABINETS AND FIRE-HAZARDOUS INDUSTRIAL CONTAINERS**

(76) Inventor: **Igor K. Kotliar**, 50 Lexington Ave. Suite 249, New York, NY (US) 10010

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/566,506**

(22) Filed: **May 8, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/551,026, filed on Apr. 17, 2000.

(51) **Int. Cl.**[7] **F24F 3/16**
(52) **U.S. Cl.** 62/78; 95/47; 95/54; 169/54
(58) **Field of Search** 95/47, 54; 62/78; 169/54

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,896,514 A * 1/1990 Sugiyama et al. 62/78
5,063,753 A * 11/1991 Woodruff 62/78
5,388,413 A * 2/1995 Major et al. 62/911
5,472,480 A * 12/1995 Barbe 95/54
5,649,995 A * 7/1997 Gast, Jr. 95/54
5,799,495 A * 9/1998 Gast, Jr. 62/78
5,921,091 A * 7/1999 Foss et al. 62/46.1

* cited by examiner

Primary Examiner—Ronald Capossela
(74) *Attorney, Agent, or Firm*—Firepass.com

(57) **ABSTRACT**

Fire prevention and suppression system is provided for computer cabinets and fire-hazardous containers. The equipment of the system provides low-oxygen environments at standard atmospheric pressure. The system employs an oxygen-extraction apparatus that supplies oxygen-depleted air inside an enclosed area communicating with the device. A fire-extinguishing composition is provided for continuous use in computer cabinets and fire-hazardous containers, consisting of oxygen-depleted air having oxygen content below 12%.

5 Claims, 3 Drawing Sheets

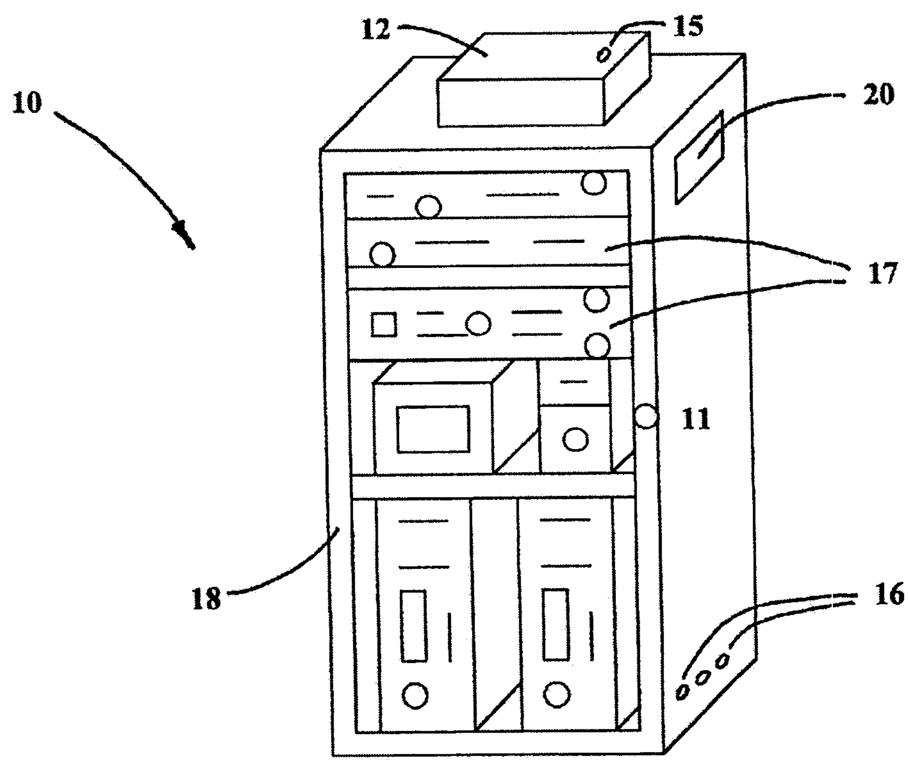


Fig. 1

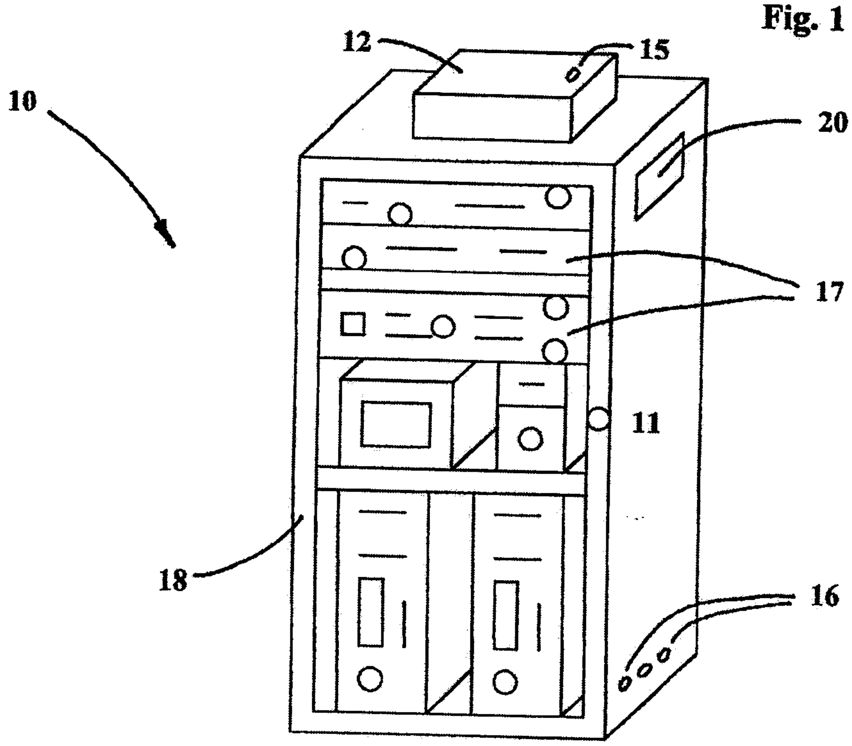


Fig. 2

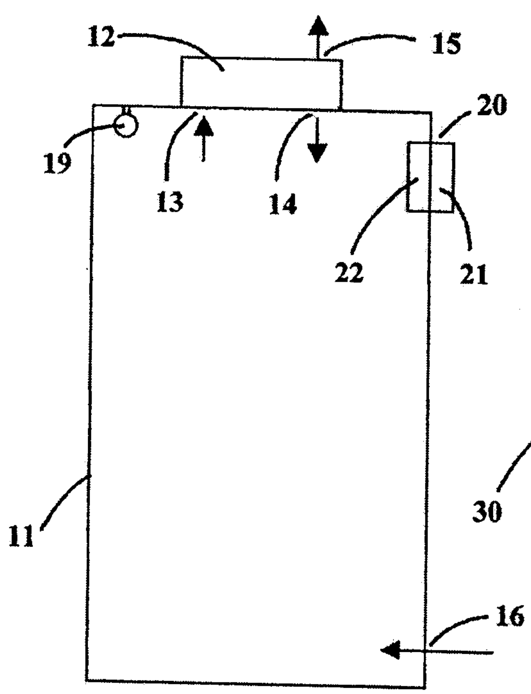


Fig. 3

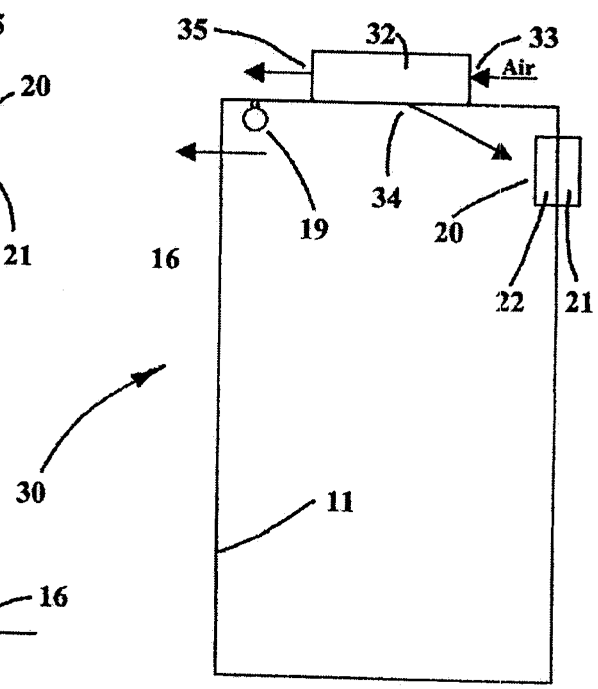
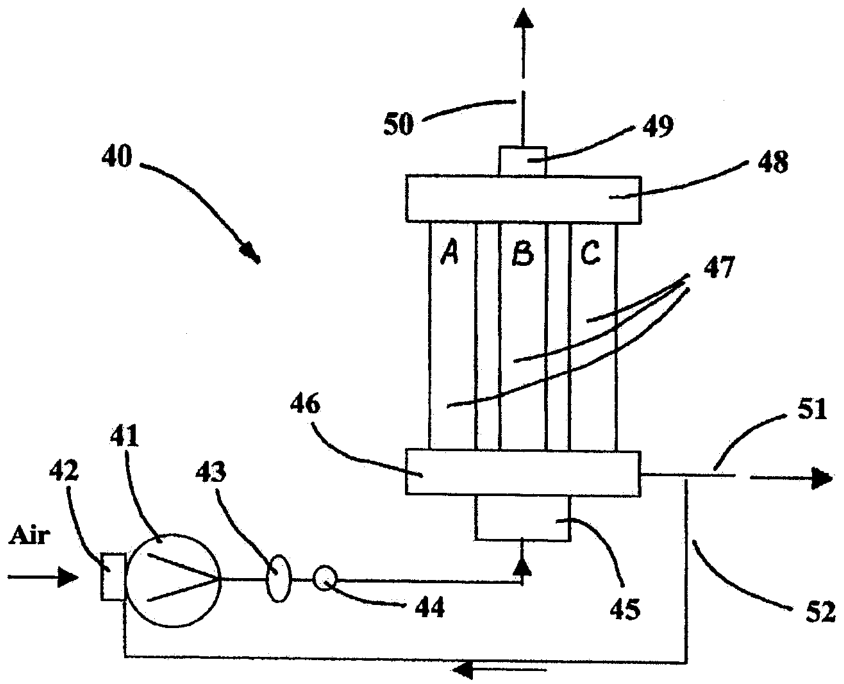


Fig. 4



50
49
48
40
A
B
C
47
46
51
41
42
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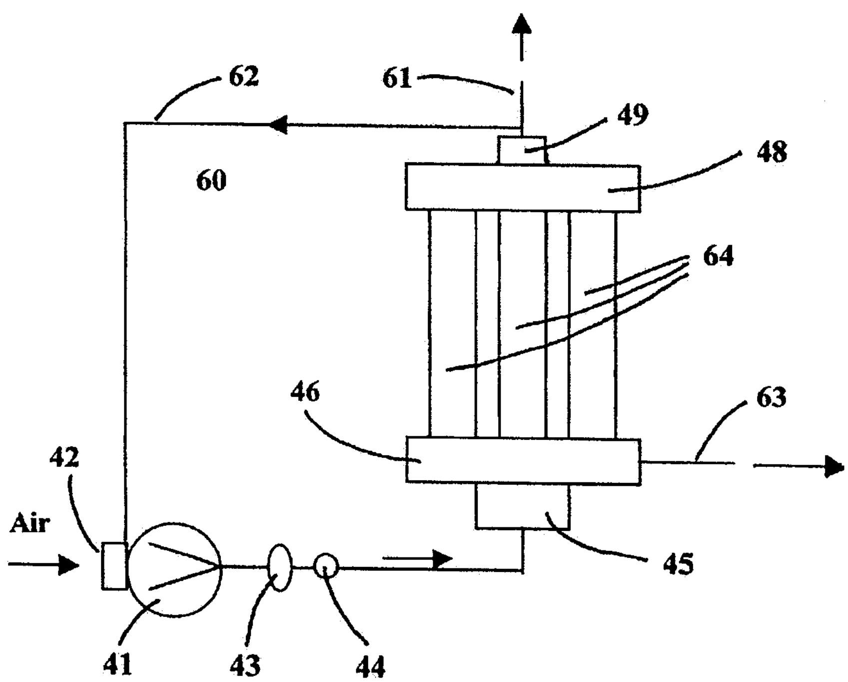
Air
44
45
52

Fig. 5



62
61
49
48
60
64
46
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42
Air
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41
43
44

Fig. 6

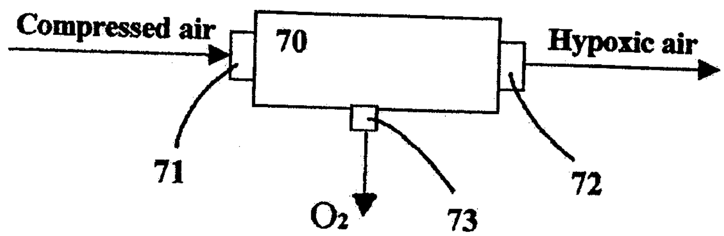
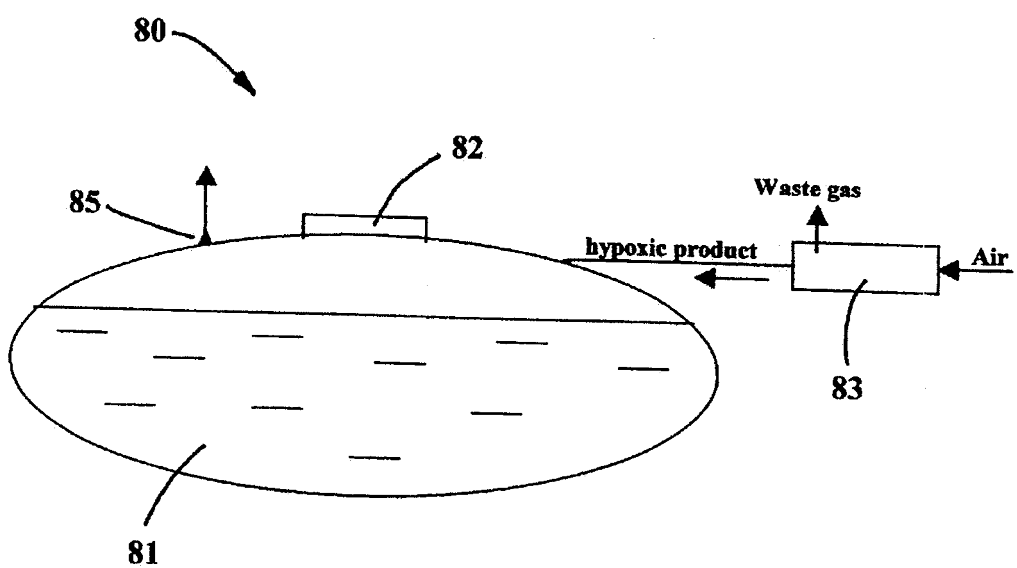

Compressed air
70
Hypoxic air
71
O_2
73
72

Fig. 7


80
82
85
Waste gas
hypoxic product
Air
83
81

HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS FOR COMPUTER CABINETS AND FIRE-HAZARDOUS INDUSTRIAL CONTAINERS

RELATED APPLICATIONS

This invention is related to preceding U.S. Pat. No. 5,799,652 issued Sept. 1, 1998, U.S. Pat. No. 5,887,439 issued Mar. 30, 1999, U.S. Pat. No. 5,924,419 of Jul. 20, 1999 and is continuation in part of the U.S. patent application Ser. No. 09/551,026 filed on Apr. 17, 2000.

FIELD OF THE INVENTION

The present invention relates to a process and equipment for providing low-oxygen (hypoxic) environments inside a computer cabinet or container with combustible or explosive material in order to prevent or suppress fire before it starts.

The demand in reliable fire prevention and suppression systems for industrial applications has been always very high and is growing extensively, especially with the explosive development of Internet, computerized equipment and communication systems. The invented Fire Prevention And Suppression System can be used in any possible application where a non-occupied environment requires protection from fire hazard or explosion.

DESCRIPTION OF THE PRIOR ART

At the present time there are no products on the market that would allow to prevent fire from igniting inside computer cabinets or other industrial enclosures containing inflammable or explosive materials. A computer or server produces a lot of heat inside its enclosure or cabinet, mainly due to friction and overheating of electronic components. At any time a malfunction of an electronic component or short circuit may cause fire and extensive damage. A spark inside a fuel container at gas station or tanker may cause immediate explosion. All current fire prevention and suppression systems are design in order to suppress fire after it starts, which might be too late. Current fire suppression systems are destructive for computerized equipment and cannot guarantee that fire will not start.

There are millions of powerful computers around the world, owned by large corporations, banks, communication companies, military and government agencies, many of them loosing millions of dollars in just one such fire.

There is no prior art on fire protection systems build inside a computer cabinet or fire hazardous container. The process and equipment described in this invention can guarantee that no fire will be able to start inside such computer cabinet or container having internal atmosphere with oxygen content under 10%.

The invention described in this document will prevent huge financial and environmental losses from industrial fires and will save many lives of fire fighters and general public.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide a method for producing a fire safe hypoxic environment inside a computer cabinet or container with combustible, inflammable or explosive materials.

Further object of the present invention is the provision of an oxygen-depletion process and an apparatus for producing a low-oxygen environment inside a computer cabinet or industrial container, such equipment employing molecular-sieve adsorption or membrane-separation technologies.

A still further object of the invention is to provide a fire-retarding oxygen-depleted environment inside a computer room or industrial facility at standard, slightly reduced or increased atmospheric pressure and having oxygen content fewer than 10%.

Another object of this invention is to establish fire safe hypoxic environments inside computer cabinets or containers with combustible, inflammable or explosive materials by providing constant ventilation of such enclosures with oxygen-depleted air in order to remove heat and/or explosive fumes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the most preferred embodiment of the fire safe computer cabinet.

FIG. 2 illustrates schematically a working principle of the invented hypoxic fire prevention and suppression system employing hypoxic generator in extraction mode.

FIG. 3 illustrates schematically an alternative working principle of the invented hypoxic fire prevention and suppression system employing hypoxic generator in supply mode.

FIG. 4 presents a schematic view of a working principle of hypoxic generator employing nitrogen adsorbing molecular-sieve material and Pressure-swing adsorption technology.

FIG. 5 presents a schematic view of a working principle of hypoxic generator employing oxygen adsorbing molecular-sieve material and Pressure-swing adsorption technology.

FIG. 6 shows schematically working principle of hypoxic generator employing Membrane air-separation technology.

FIG. 7 illustrates a schematic view of an industrial container filled with highly inflammable fluid.

DESCRIPTION OF THE INVENTION

It is well known that combustion process requires oxygen, therefore the goal of this invention is to provide an extreme hypoxic normbaric environment inside a computer cabinet or any container in order to eliminate fire hazard completely.

This invention is based on a discovery made by the inventor during research with the Hypoxic Room System made by Hypoxico Inc. in New York. It was discovered that a normbaric hypoxic environment provides a different effect on ignition and combustion process than hypobaric or natural altitude environments with the same partial pressure of oxygen. For example, gasoline or any gas lighter would ignite and bum on an altitude of 19,000' (5,800 m) in the air having partial pressure of oxygen at 2.99" (76 mm) of mercury.

However, if we create a corresponding normbaric hypoxic environment with the same partial pressure of oxygen at 2.99" or 76 mm of mercury, we will find that gasoline will not burn or even ignite. Any attempt to ignite it would fail because even a gaslighter or gas torch would not ignite in this environment. It means that normbaric environments with corresponding oxygen content of 10% are absolutely safe against any fire hazard.

This invention provides reliable and inexpensive process and equipment for producing such fire-retarding environment inside a computer cabinet or container with fire hazardous material.

FIG. 1 shows the most preferred embodiment of the fire safe computer cabinet system **10** consisting of cabinet

enclosure 11 having (in this case clear) door 18 and air intake openings 16 and filled with computer equipment or components 17, further having hypoxic generator 12 mounted on the top of the cabinet enclosure 11.

FIG. 2 shows schematically a working principle of the invented hypoxic fire prevention and suppression system 10 employing hypoxic generator in extraction mode.

The fire safe computer cabinet system 10 consists of a computer rack or cabinet enclosure 11 filled with computer devices or components and hypoxic generator 12 mounted directly on cabinet enclosure 11 and having air intake 13 and outlets 14 and 15. Computer cabinet 11 does not have to be absolutely airtight—it has multiple openings or holes 16, preferably in its lower portion. Openings 16 are shown schematically for better understanding of air circulation inside cabinet 11. In reality there is no need for special openings because air will always be able to enter cabinet through gaps around the door or through semi-airtight enclosure.

Hypoxic generator 12 draws air from the cabinet 11 through the intake 13 and extracts a part of oxygen from it allowing oxygen depleted air back into cabinet 11 through outlet 14. Oxygen-enriched gas mixture is disposed into atmosphere through disposal outlet 15. This process creates a slightly negative pressure inside cabinet 11 that works as a driving force for intaking fresh air through the openings 16, in order to equalize atmospheric pressures inside and outside of cabinet 11. Therefore semi-airtight cabinet 11 and even holes 16 in it are absolutely necessary functional components of this fire-retarding system.

Hypoxic generator starts working when door 18 is closed. At the beginning, the oxygen-enriched gas being removed from the system through disposal outlet 15 has a little higher oxygen content (about 30%) than ambient air entering cabinet 11 through holes 16 (20.94% at sea level). It means that oxygen content inside cabinet 11 will start dropping to a certain level below 10%. At the same time the oxygen content in the disposal fraction will also decrease to about ambient air level. The higher oxygen content in the disposal fraction, the lower will be the oxygen content inside cabinet 11. The lowest possible oxygen content inside cabinet 11 will be about 4.5%. Most important in the invented system is that it does not affect air composition in the room where the system 10 is installed. After oxygen content in cabinet 11 drops to desired level, the system 10 becomes balanced and will extract composition with oxygen content close to ambient air.

When oxygen content inside cabinet 11 drops below 7%, which will be detected by oxygen transducer 19 installed inside cabinet 11, hypoxic generator 12 turns off in order to save energy. When, after some time, oxygen content inside cabinet 11 reaches about 12%, transducer 19 will turn on hypoxic generator 12 again, and so further in cycles. Expensive oxygen transducer 19 is optional and can be replaced by a simple timer, which can turn on and off hypoxic generator 12 in preset intervals of time.

An air-cooling device 20 is installed in order to reduce temperature inside cabinet 11. The device 20 consists of thermoelectric module having cold sink plate 22 inside cabinet 11 and heat sink 21 outside cabinet 11. Big advantage of thermoelectric modules is the absence of refrigerant or any moving parts. Working principle of a thermoelectric cooler is well known and such devices are available on the market. Suitable device with high-performance thermoelectric module and high-fin-density cold sink and heat sink can be bought from TE Technology Inc. in Michigan, U.S.A.

It is advisable to direct the gas flow from outlet 14 against the cold sink 22 of the cooler 20 in order to provide better circulation of cold gas mixture inside cabinet 11 and better cooling of electronic components 17. Cooler 20 can be equipped with a simple thermostat that will control temperature inside cabinet 11 and save energy by turning off the cooler 20 when desired low temperature is reached.

FIG. 3 illustrates schematically an alternative working principle of the invented hypoxic fire prevention and suppression system 30 employing hypoxic generator 32 in supply mode. This embodiment does not change anything in design of cabinet 11 and all other components. The only difference is in configuration of hypoxic generator 32 that is the same as generator 12, but connected different way to cabinet 11.

Hypoxic generator 32 takes in ambient air through intake 33 and separates it into oxygen-depleted fraction being transmitted inside cabinet 11 through outlet 34 and oxygen-enriched fraction being disposed into atmosphere through disposal outlet 35. This way cabinet 11 becomes constantly ventilated with low-oxygen gas mixture. Hypoxic generator shown below on FIG. 4 will be available in 2001 from Hypoxico Inc. in New York. It can provide oxygen-depleted air with any oxygen concentration in the range from 5% to 10%, which can be exactly preset at the factory.

The oxygen-depleted air entering cabinet 11 through outlet 34 is directed against cold sink 22 of the thermoelectric cooler 20 and sinks further down to the bottom of cabinet 11. In this embodiment openings 16 are moved to the higher position in order to exhaust warm gas mixture instead of cool one at the bottom of cabinet. This way, an effective air circulation inside cabinet 11 is assured, providing better cooling of computer components 17. The invented system 30 is entirely safe because disposal fraction having only slightly increased oxygen content of about 30% is instantly dissociated in the surrounding atmosphere. The system 30 does not affect air composition in surrounding atmosphere in any way because the oxygen amount in both fractions exiting the system is equivalent to the amount of oxygen in the air entering the system. Constant ventilation of the internal environment allows to remove heat from cabinet 11. This embodiment is most suitable for fire-hazardous containers because constant ventilation will allow removing of explosive fumes.

All parts of the systems 10 and 30 are shown schematically, in order to provide better understanding of the working principle. For instance, thermoelectric cooler 20 could be build in the air supply line before outlet 14 or 34, or hypoxic generator could be a free-standing unit connected with cabinet 11 through air conduits. Computer rack enclosure 11 can be computer cabinet or container with fire-hazardous materials. Transducer or timer 19 and cooler 20 are optional in some applications.

Other oxygen-extraction devices employing molecular-sieve adsorption, membrane-separation or other technologies can be used instead on hypoxic generator 12 or 32 in the invented system. However, it is highly recommended to use reliable hypoxic generators specially designed by Hypoxico Inc. in New York.

FIG. 4 presents a schematic view of a working principle of hypoxic generator HYP-10/PSA/Z employing Pressure-swing adsorption technology, which will be available from Hypoxico Inc. in New York in 2001. This hypoxic generator 40 produces about 10 liters per minute of hypoxic air with preset oxygen content in the product between 5% and 10%. Miniature hypoxic generators producing 0.5 to 5 liters per

minute will be available for smaller cabinets as well. All these generators employ molecular-sieve materials, mainly synthetic zeolites that adsorb nitrogen and allow oxygen to pass through the adsorbing material.

Compressor 41 draws ambient air through intake filter 42 and pressurizes it to about 15 psi or 1 bar. Further compressed air is chilled in air cooler 43 and transmitted through high-efficiency air filter 44 into distribution valve 45 mounted on manifold 46.

3 elongated containers 47 with molecular sieve material are mounted on manifold 46 the way that pressurized air is selectively and in cycles delivered into each container 47 allowing to pressurize them for several seconds at about 15 psi or 1 bar. Number of containers 47 may vary from 1 to 12 or more and they can be pressurized individually or in groups. On the other end all containers are interconnected with a collecting tank 48 having release valve 49.

Under pressure molecular sieve material in containers 47 allows oxygen-enriched fraction to pass through into tank 48, adsorbing remaining air gases, including mostly nitrogen and water vapors. Oxygen-enriched fraction is disposed into atmosphere through release valve 49 and disposal outlet 50. Distribution valve 45 continuously in cycling manner redirects the flow of compressed air from one container to two others. After several seconds of pressurization the molecular sieve material in container A becomes saturated with nitrogen-enriched fraction. At this time distribution valve 45 takes first position by opening container A for depressurization and redirects the flow of compressed air into containers B and C.

The nitrogen-enriched fraction from container A is transmitted inside manifold 46 into product outlet 51 having recycling loop 52. Part of nitrogen-rich product is transmitted through recycling loop 52 back into compressor intake 42. This allows significantly increasing efficiency of the hypoxic generator 40 without increasing working pressure, power consumption and weight. Low working pressure allows extending compressor life up to 5 years or more without any maintenance. Recycling loop 52 is only active for generators in supply mode as shown in embodiment 30 and is closed in generators working in extraction mode as shown on FIG. 2.

During the depressurization cycle of container A, a small amount of oxygen-enriched fraction being kept in tank 48 under minimal pressure by valve 49 is released back into container A, purging it from contaminating nitrogen.

Second position of distribution valve 45 sets containers C and A under pressure, depressurizing container B and transmitting its content into product outlet 51.

Third and last position of distribution valve 45 opens container C for depressurization and directs compressed air into containers A and B.

There is large selection of suitable distribution valves available on the market: from mechanical and electric to solenoid and air-piloted, both linear and rotary types. For this reason, working principles of these devices will be not explained in this work further. It is not difficult for those skilled in the art to find suitable valve and manifold for any number of containers 47 or their groups.

FIG. 5 presents a schematic view of an alternative working principle of hypoxic generator 60 employing the same Pressure-swing adsorption technology, but different adsorbent that adsorbs oxygen and allows nitrogen to pass through the adsorbing material. Carbon molecular-sieve material (CMSO2) has tiny hollow traps in its porous structure called "bottlenecks" that allow oxygen molecules to get in under pressure. Most of oxygen molecules being "trapped" inside such "bottlenecks" cannot find their way out in their chaotic movements. This technology is well known to those skilled in the art and is used in nitrogen generators.

Most of the components of the generator 60 are the same as in embodiment 40 and their working principle will not be described again. The only difference in this embodiment is that product and disposal outlets replace each other.

Compressed air pressurizes selectively containers 64 with oxygen adsorbing molecular-sieve material that allows nitrogen-enriched fraction to pass through into product outlet 61 via collecting tank 48 and release valve 49. A part of the product is returned back into system 60 through recycling conduit. 62. Oxygen-enriched adsorbat is released into atmosphere through disposal outlet 63.

Hypoxic generators 12 and 32 may also employ oxygen-enrichment membrane 70 that is schematically shown on FIG. 6. Usually such membranes are made as elongated container filled with synthetic hollow fibers that permit oxygen under pressure through their walls and allow nitrogen-enriched fraction to pass through the hollow fibers.

Compressed air enters membrane 70 through inlet 71 and is separated there into oxygen-enriched permeate being disposed through outlet 73 and hypoxic product delivered via product release valve 72.

FIG. 7 shows another embodiment 80 of the invented Fire Prevention and Suppression System. A fire-hazardous industrial container 81 contains highly inflammable liquid (alcohol, acetone, gasoline, kerosene, liquid gas, paint, etc.) or dry fire-hazardous and explosive materials. Container 81 can be any industrial container, including stationary and mobile fuel tanks, sea tankers and cargo ships, underground fuel tanks at gas stations, dip and quench tanks, spray and coatings containers, spill containment dikes, storage enclosures and cabinets and other containers with fire hazardous materials and compositions.

Hypoxic generator 83 can be installed directly on container 81 like shown in embodiments 10 and 30 or at remote location, as shown on FIG. 7. It is advisable for such cases to use hypoxic generator in supply mode as shown in embodiment 30.

Hypoxic generator 83 supplies oxygen-depleted air into tank 81 having a hatch or entry 82 and/or vent 85. Heavy nitrogen rich product covers surface of the inflammable liquid and fills the rest of the container 81 replacing explosive vapors being expelled from container 81 through vent 85 or ventilation hole in hatch 82. Waste gas containing enriched-oxygen fraction is disposed from generator 83 into atmosphere.

Such fire-retarding environment can be kept inside tank 81 permanently by supplying nitrogen rich product in necessary intervals—after fire safe environment with the lowest oxygen content is established, generator 83 can be shut down and turned on again by a timing device.

The invented technology should be applied for ventilating underground communication tunnels, mining facilities, munitions and missile bunkers, underground military installations and other facilities in order to remove explosive gases and replace them with fire safe hypoxic air.

What is claimed is:

1. A system for providing a fire-extinguishing atmosphere in enclosed environments, said system comprising:

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated

with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below 12%;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing a molecular-sieve adsorber and said intake being operatively associated with a distribution valve providing distribution of said intake gas to multiple inlets each communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs nitrogen and water vapors and allows said enriched-oxygen gas mixture to pass through into collecting tank communicating with said second outlet;

said collecting tank being operatively associated with all said separation containers and receiving selectively said enriched-oxygen gas mixture therefrom;

said separation containers being selectively pressurized and depressurized in cycles and releasing during each depressurization cycle said reduced-oxygen gas mixture being delivered into said first outlet;

said second outlet having release valve allowing to keep said enriched-oxygen gas mixture being collected in said collecting tank under increased atmospheric pressure, so when any of said separation containers depressurizes, a portion of said enriched-oxygen gas mixture is released from said tank back into said container purging said molecular sieve material from remaining nitrogen and water.

2. A system for producing a fire-extinguishing atmosphere in enclosed environments, said system comprising:

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below 12%;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing a molecular-sieve adsorber and said intake being operatively associated with a distribution valve providing distribution of said intake gas to multiple inlets each communicating with an individual gas separation container filled with molecular-sieve material that under pressure adsorbs oxygen and allows said reduced-oxygen gas mixture to pass through into collecting tank communicating with said first outlet;

said collecting tank being operatively associated with all said separation containers and receiving selectively said reduced-oxygen gas mixture therefrom;

said separation containers being selectively pressurized and depressurized in cycles and releasing during each depressurization cycle said enriched-oxygen gas mixture being delivered into said second outlet.

3. The apparatus according to claim 1 and

said distribution valve being air distribution device selected from the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

said distribution valve being communicating with and mounted on manifold that is selectively communicating with said multiple separation containers and said first outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said reduced-oxygen gas mixture therefrom.

4. The apparatus according to claim 2 and

said distribution valve being air distribution device selected from the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

said distribution valve being communicating with and mounted on manifold that is selectively communicating with said multiple separation containers and said second outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said enriched-oxygen gas mixture therefrom.

5. An apparatus for producing a fire-extinguishing atmosphere in enclosed environments, said apparatus comprising:

a compressor having an inlet and a compressed gas outlet;

an air separation device having an intake and first and second outlets, said intake is operatively associated with said compressed gas outlet and receiving an intake gas under pressure from said compressor;

said device taking in said intake gas and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said intake gas through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said intake gas through said second outlet;

said first outlet providing a fire-retarding gas mixture for said enclosed environments with oxygen content below 12%;

said second outlet selectively communicating with outside atmosphere and releasing said enriched-oxygen gas mixture into said outside atmosphere;

said air separation device employing a membrane air separator for separating said intake gas into said reduced-oxygen and enriched-oxygen gas mixtures.

* * * * *

US006418752B2

(12) **United States Patent**
Kotliar

(10) **Patent No.: US 6,418,752 B2**
(45) **Date of Patent: Jul. 16, 2002**

(54) **HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS AND BREATHABLE FIRE EXTINGUISHING COMPOSITIONS FOR HUMAN OCCUPIED ENVIRONMENTS**

(76) Inventor: **Igor K. Kotliar**, P.O. Box 2021, New York, NY (US) 10159-2021

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/750,801**

(22) Filed: **Dec. 28, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/551,026, filed on Apr. 17, 2000, now Pat. No. 6,314,754.

(51) **Int. Cl.**[7] **F25J 1/00**
(52) **U.S. Cl.** **62/640**; 62/78; 169/45; 169/61
(58) **Field of Search** 62/78; 169/45, 169/56, 61

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,896,514 A	*	1/1990	Sugiyama et al.	62/78
5,063,753 A	*	11/1991	Woodruff	62/78
5,388,413 A	*	2/1995	Major et al.	62/911
5,472,480 A	*	12/1995	Barbe	95/54
5,649,995 A	*	7/1997	Gast, Jr.	95/54
5,799,495 A	*	9/1998	Gast, Jr.	62/78
5,799,652 A	*	9/1998	Kotliar	128/205.11
5,921,091 A	*	7/1999	Foss et al.	62/46.1
6,012,533 A	*	1/2000	Cramer	169/45

* cited by examiner

Primary Examiner—Ronald Capossela
(74) *Attorney, Agent, or Firm*—Fire PASS Corp.

(57) **ABSTRACT**

Fire prevention and suppression systems and breathable fire-extinguishing compositions are provided for rooms, houses and buildings, transportation tunnels and vehicles, underground and underwater facilities, marine vessels, aircraft, space stations and vehicles, military installations and vehicles, and other human occupied objects and facilities. The system provides a low-oxygen (hypoxic) fire-preventive atmosphere at standard atmospheric or slightly increased pressure. The system employs an oxygen-extraction apparatus supplying oxygen-depleted air inside a human-occupied area or storing it in a high-pressure container for use in case of fire. A breathable fire-extinguishing composition, being mostly a mixture of nitrogen and oxygen and having oxygen content ranging from 12% to 17% for fire-preventive environments. The fire-suppression system is provided having fire-extinguishing composition with oxygen concentration under 16%, so when released it creates a breathable fire-suppressive atmosphere having oxygen content from 10 to 16%. A technology for automatically maintaining a breathable fire-preventive composition on board a human-occupied hermetic object is provided.

28 Claims, 20 Drawing Sheets

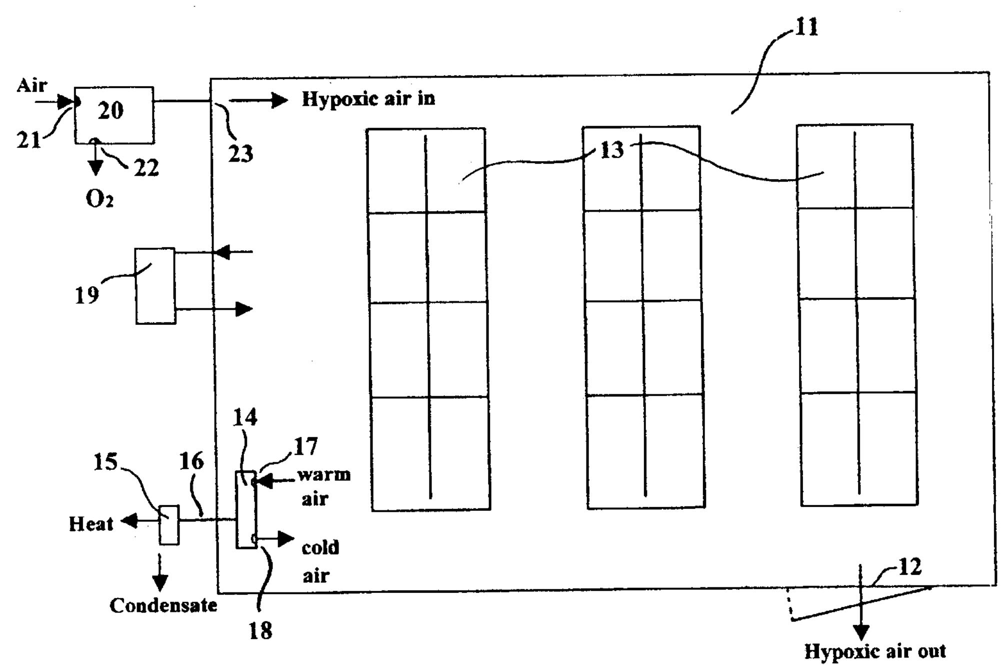


Fig. 1

Altitude or hypobaric environment

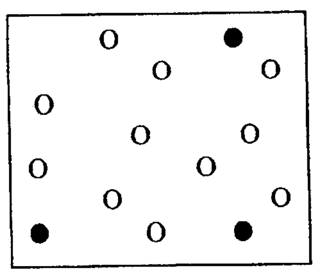


Fig. 2

Normbaric hypoxic environment

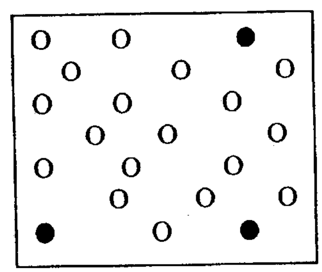
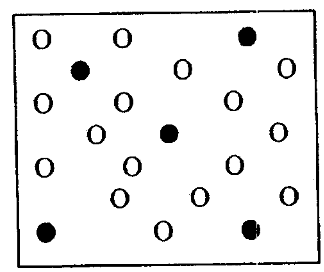


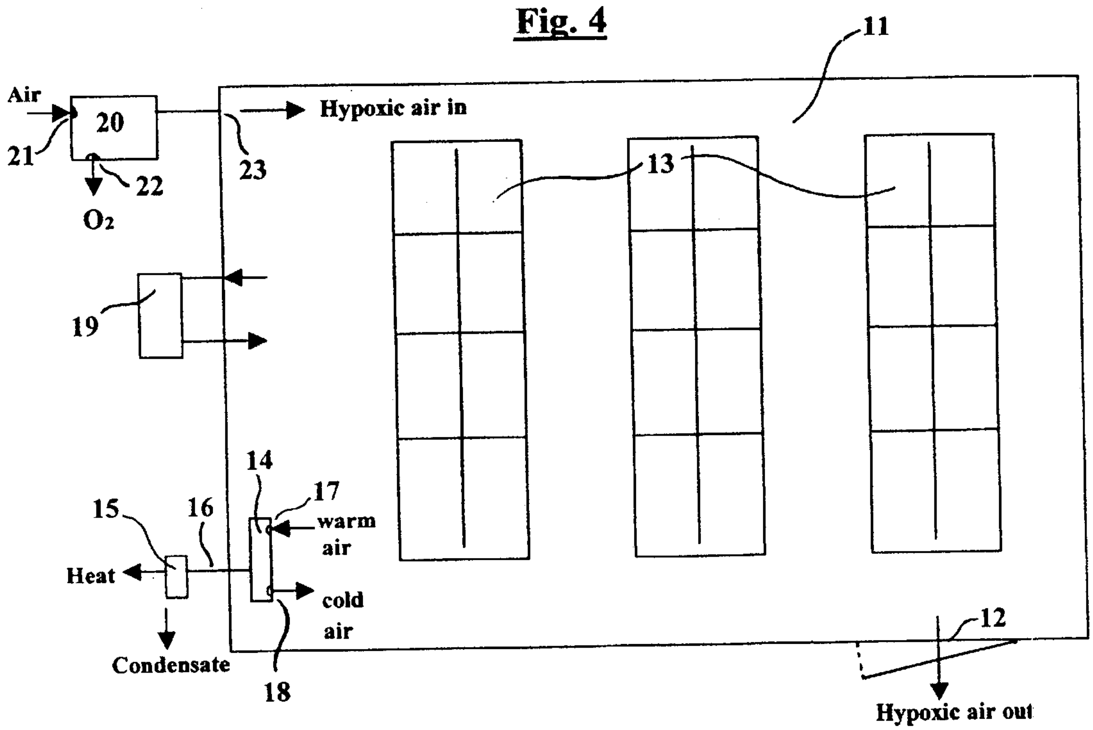
Fig. 3

Normbaric normoxic environment



● – oxygen molecules   O – nitrogen molecules

Fig. 4



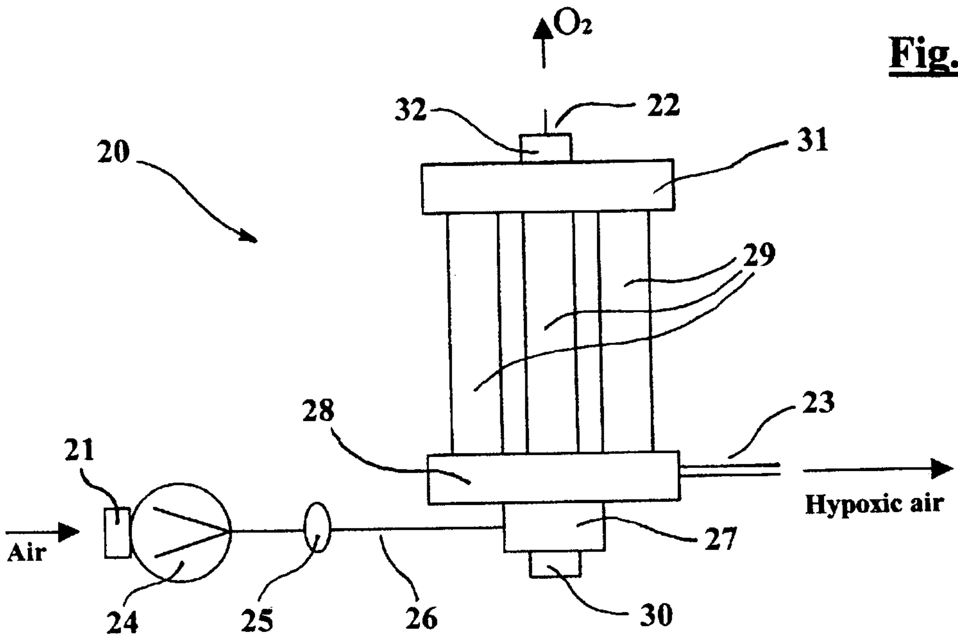


Fig. 5

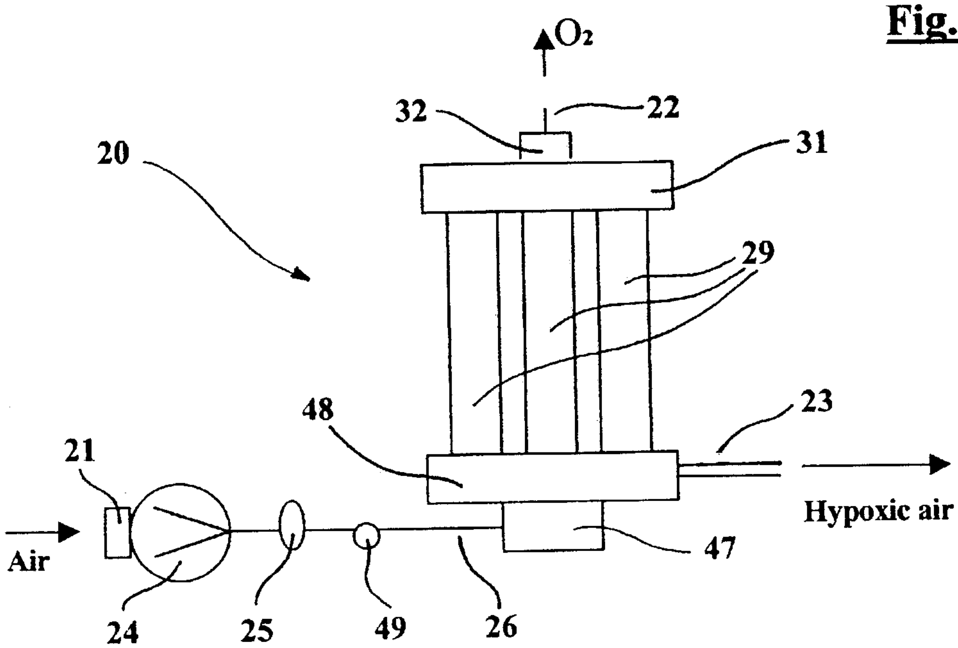


Fig. 6

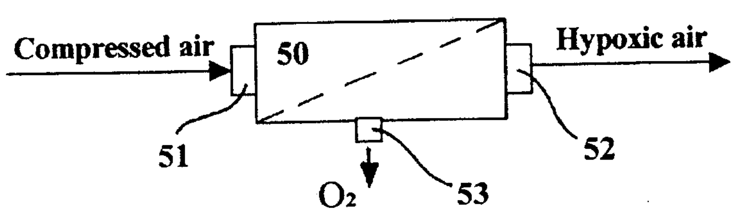
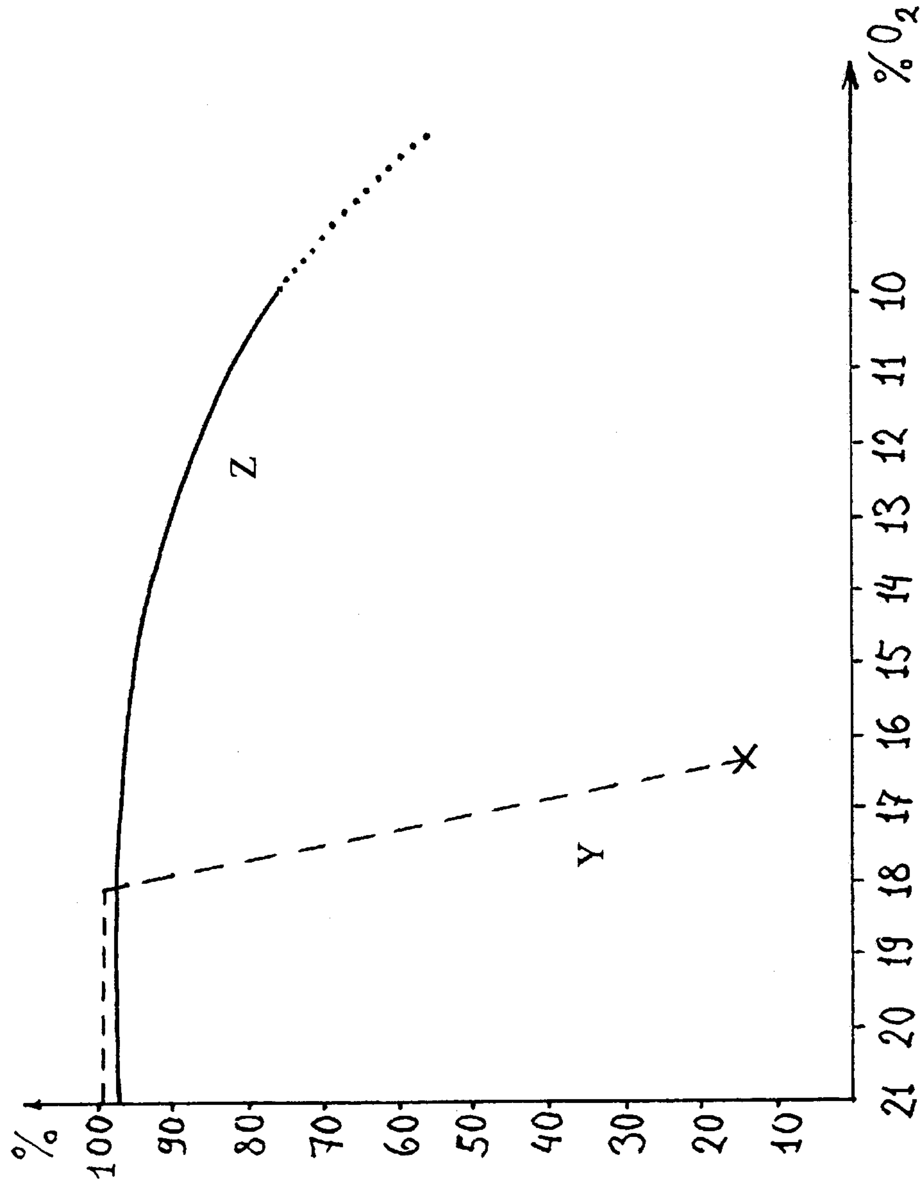


Fig. 7

Fig. 8



Z – The oxygen hemoglobin saturation curve

Y – The flame extinction curve in oxygen – reducing atmosphere

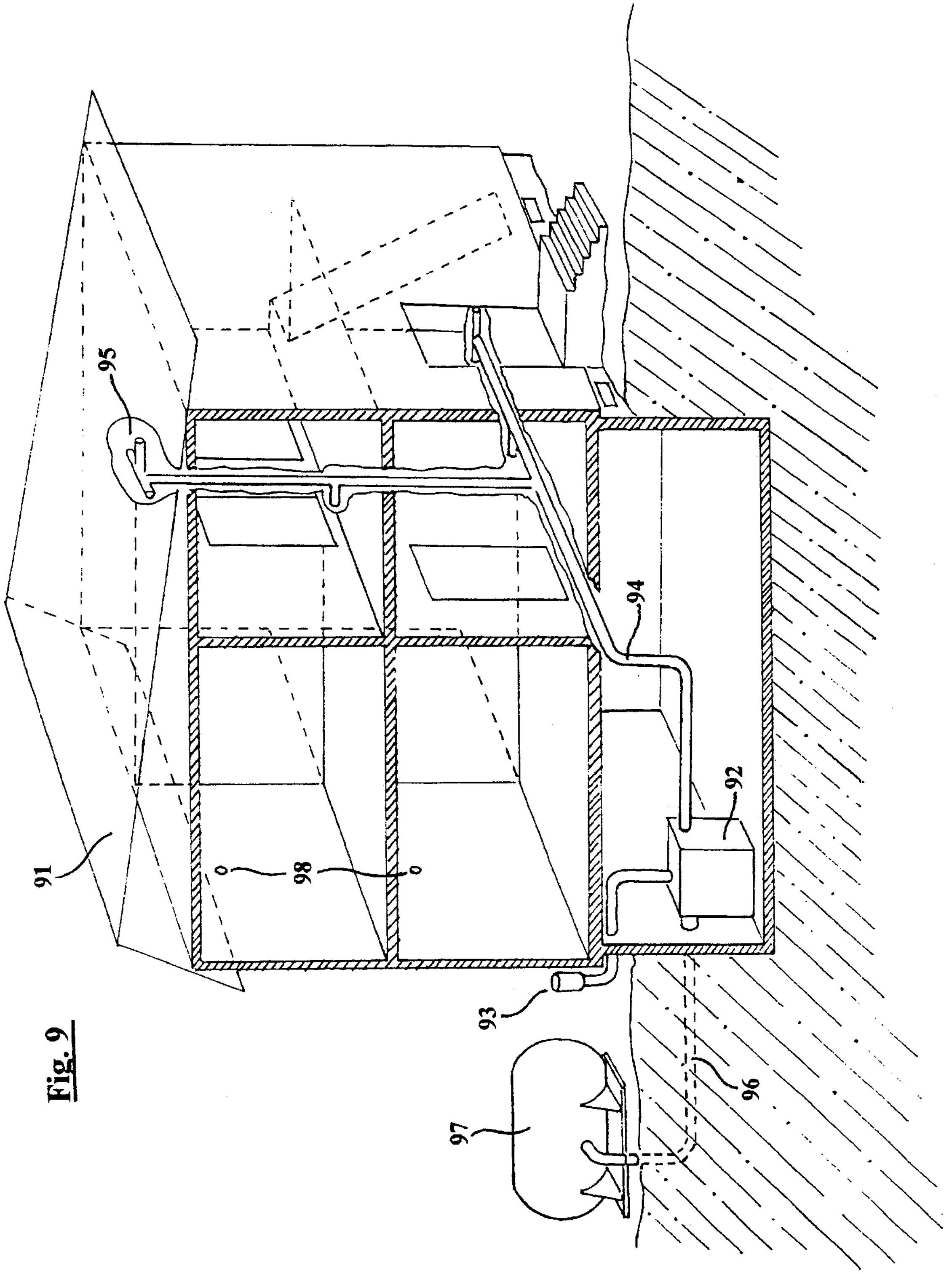
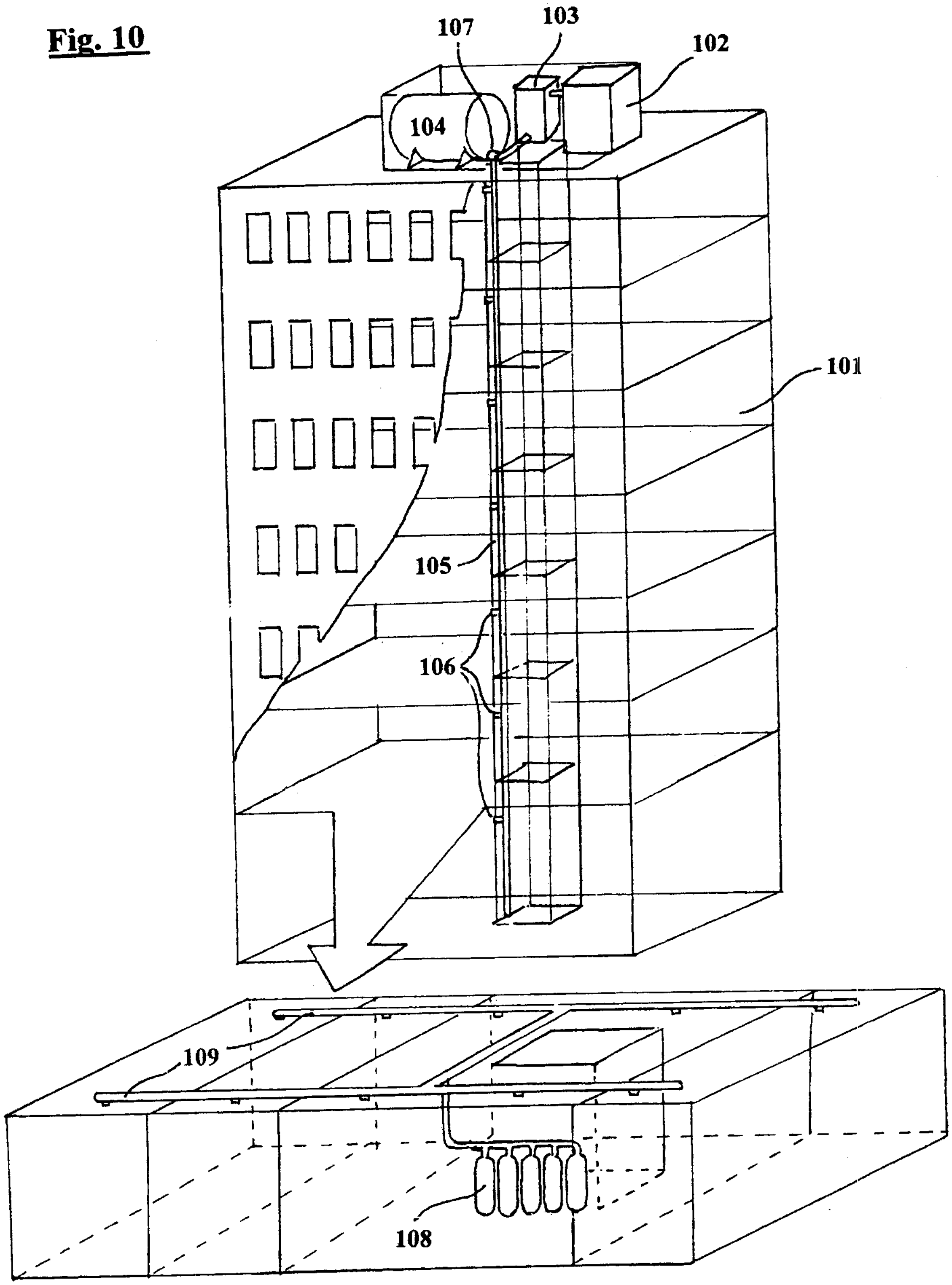


Fig. 9

Fig. 10



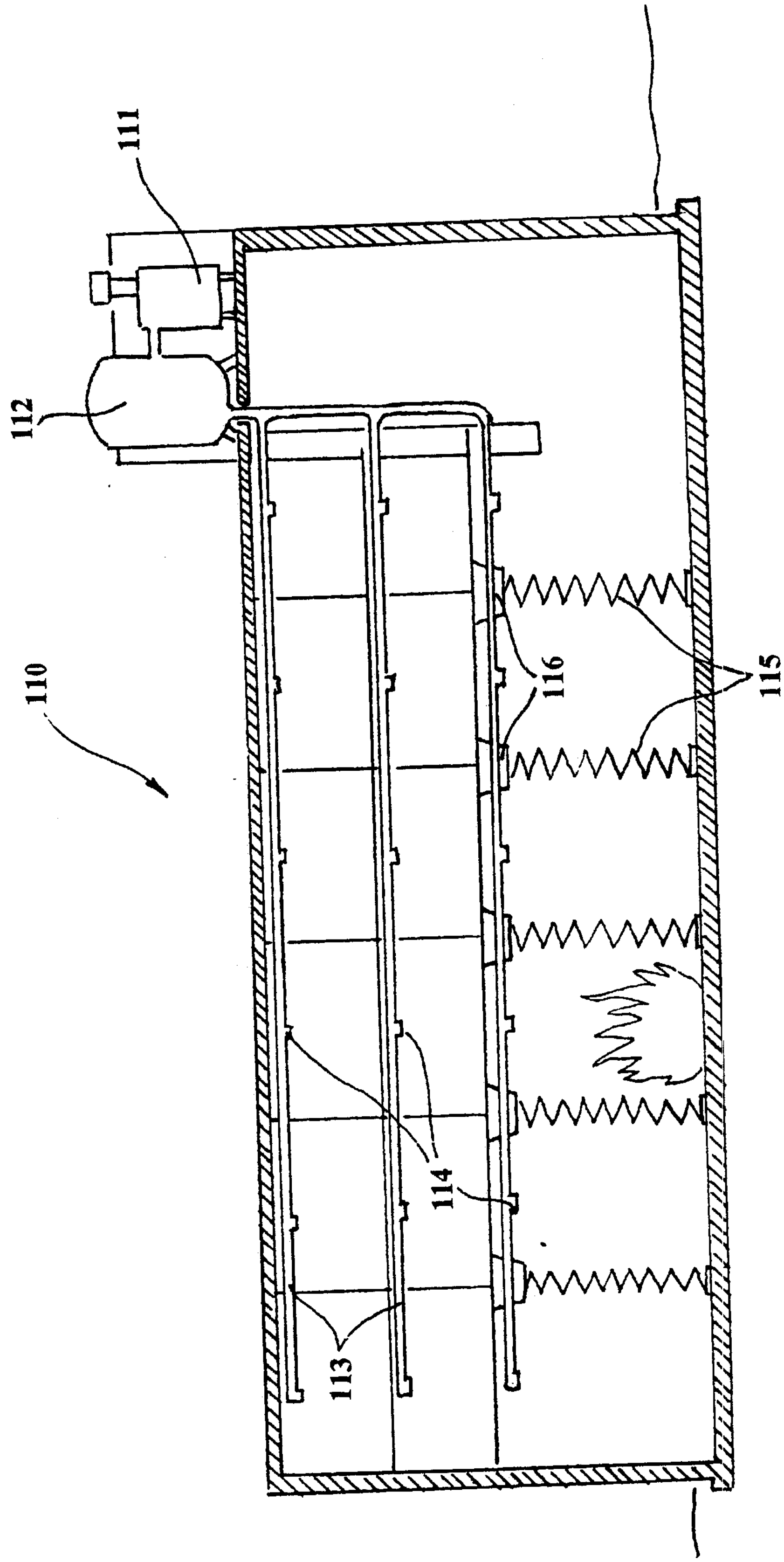


Fig. 11

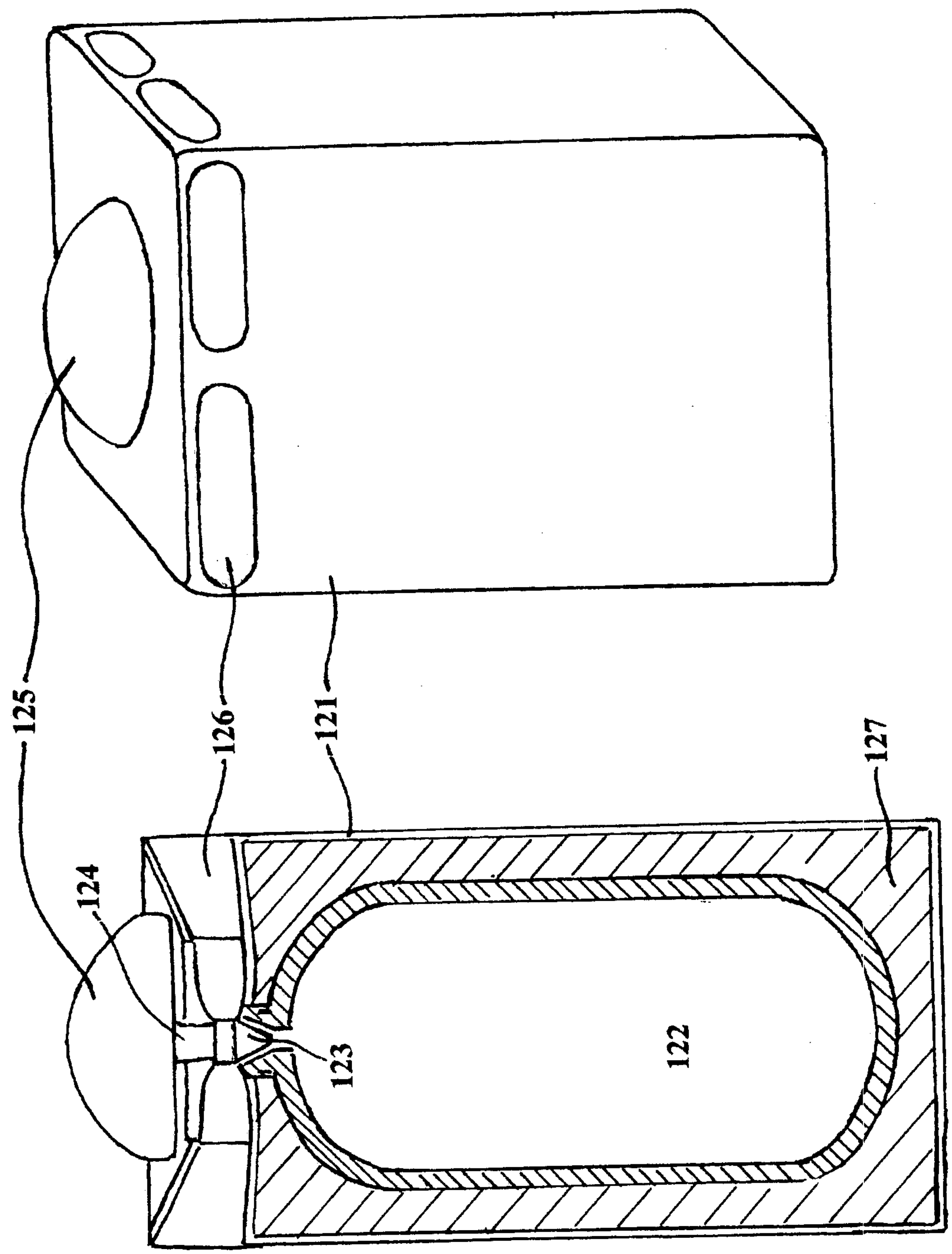


Fig. 12

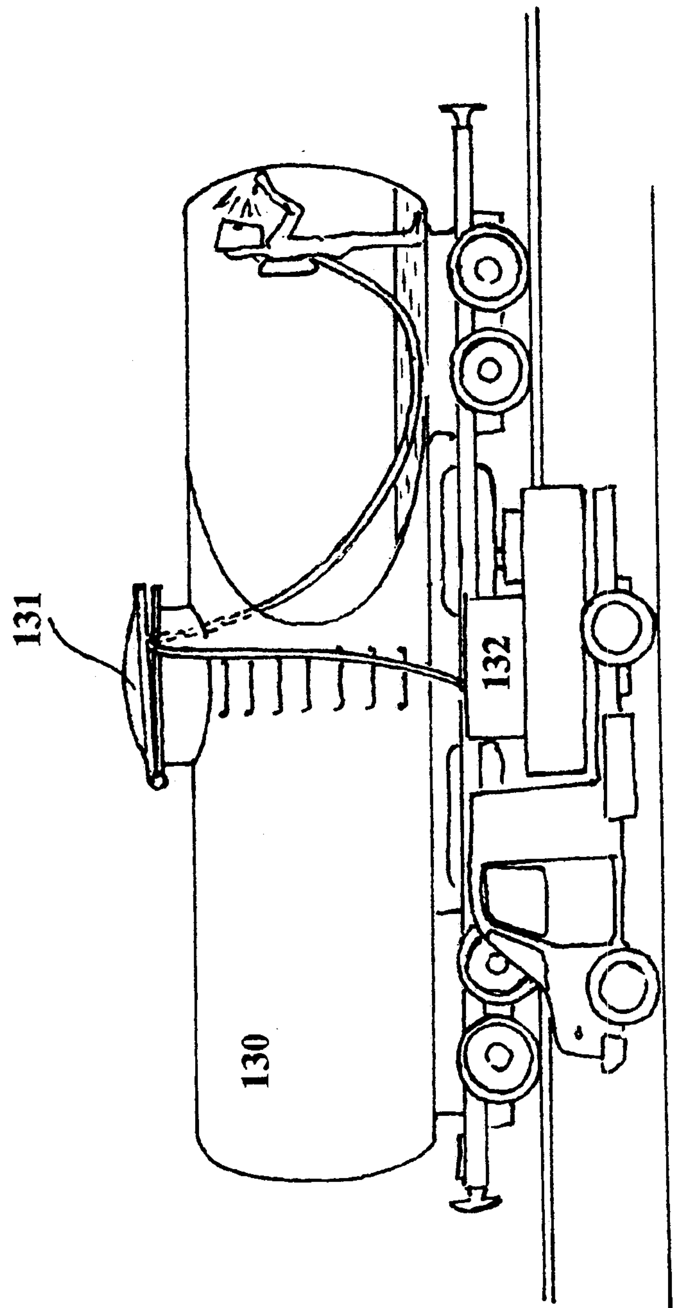


Fig. 13

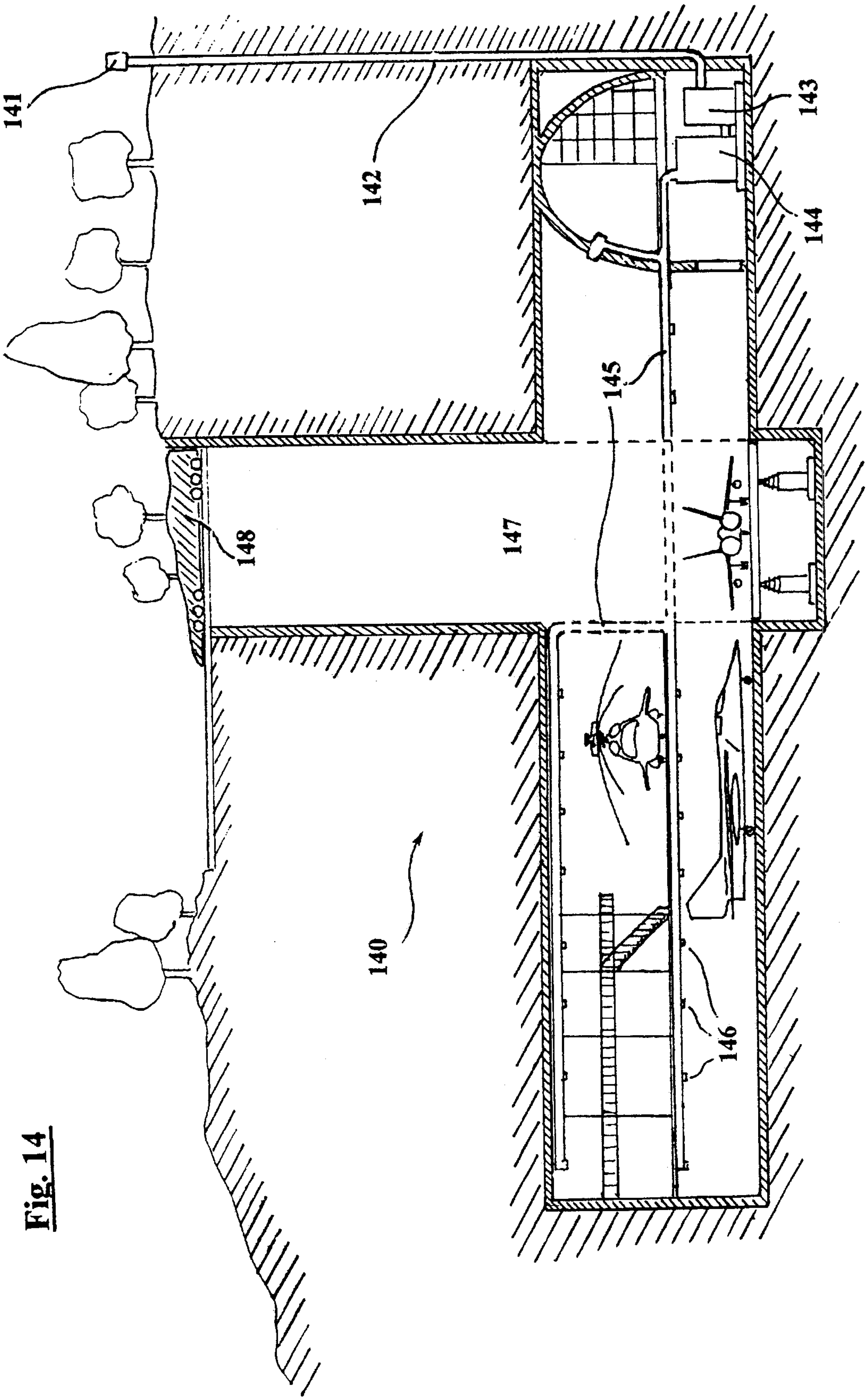


Fig. 14

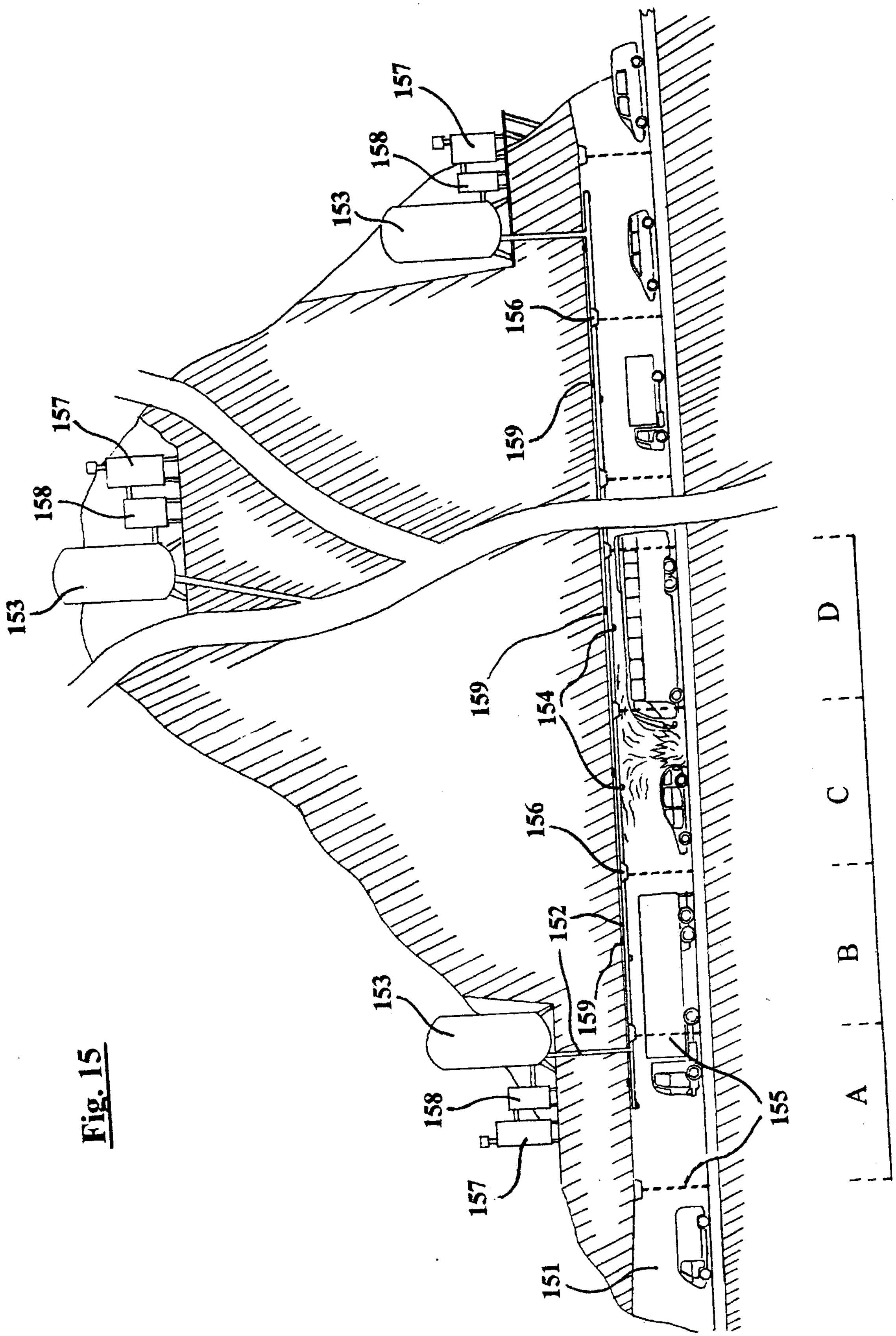


Fig. 15

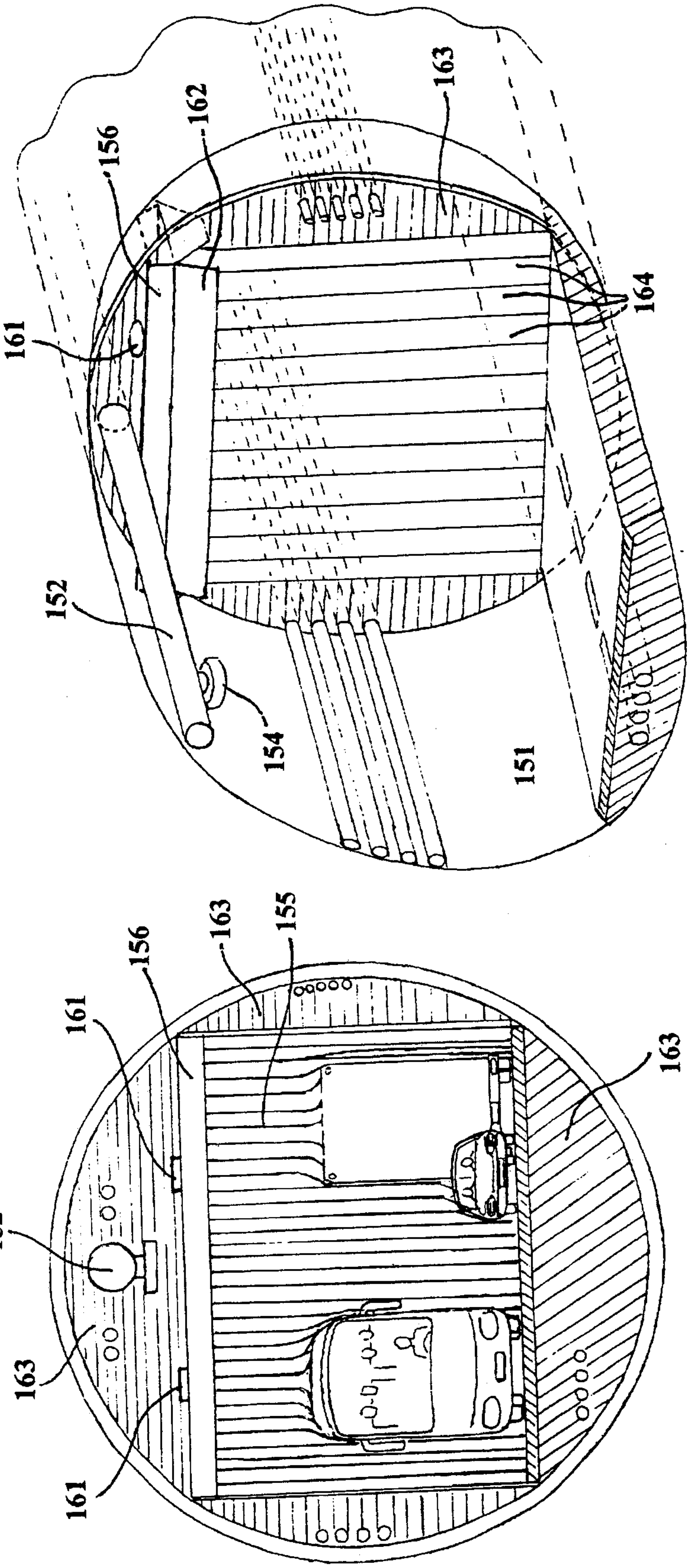


Fig. 16

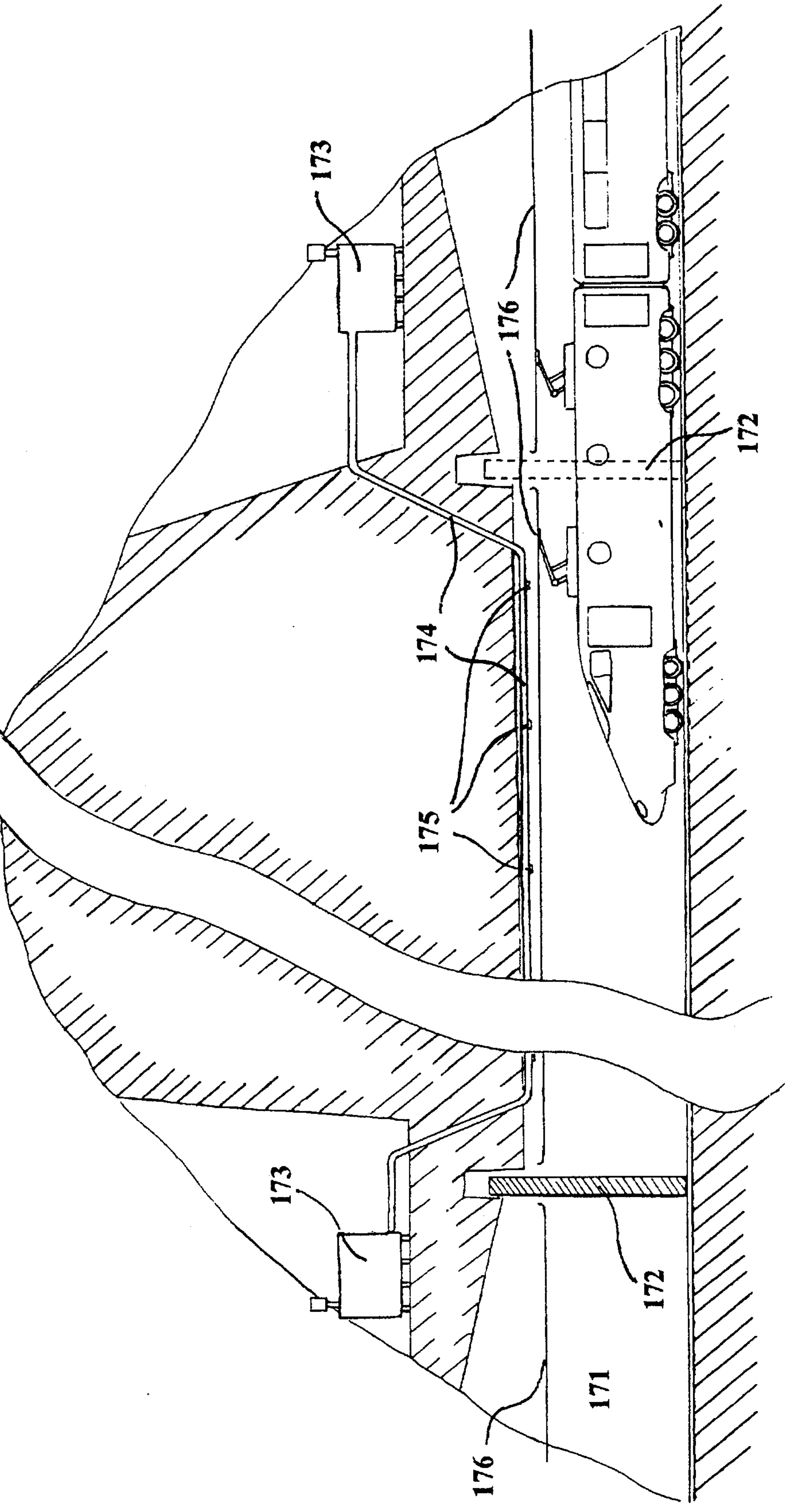
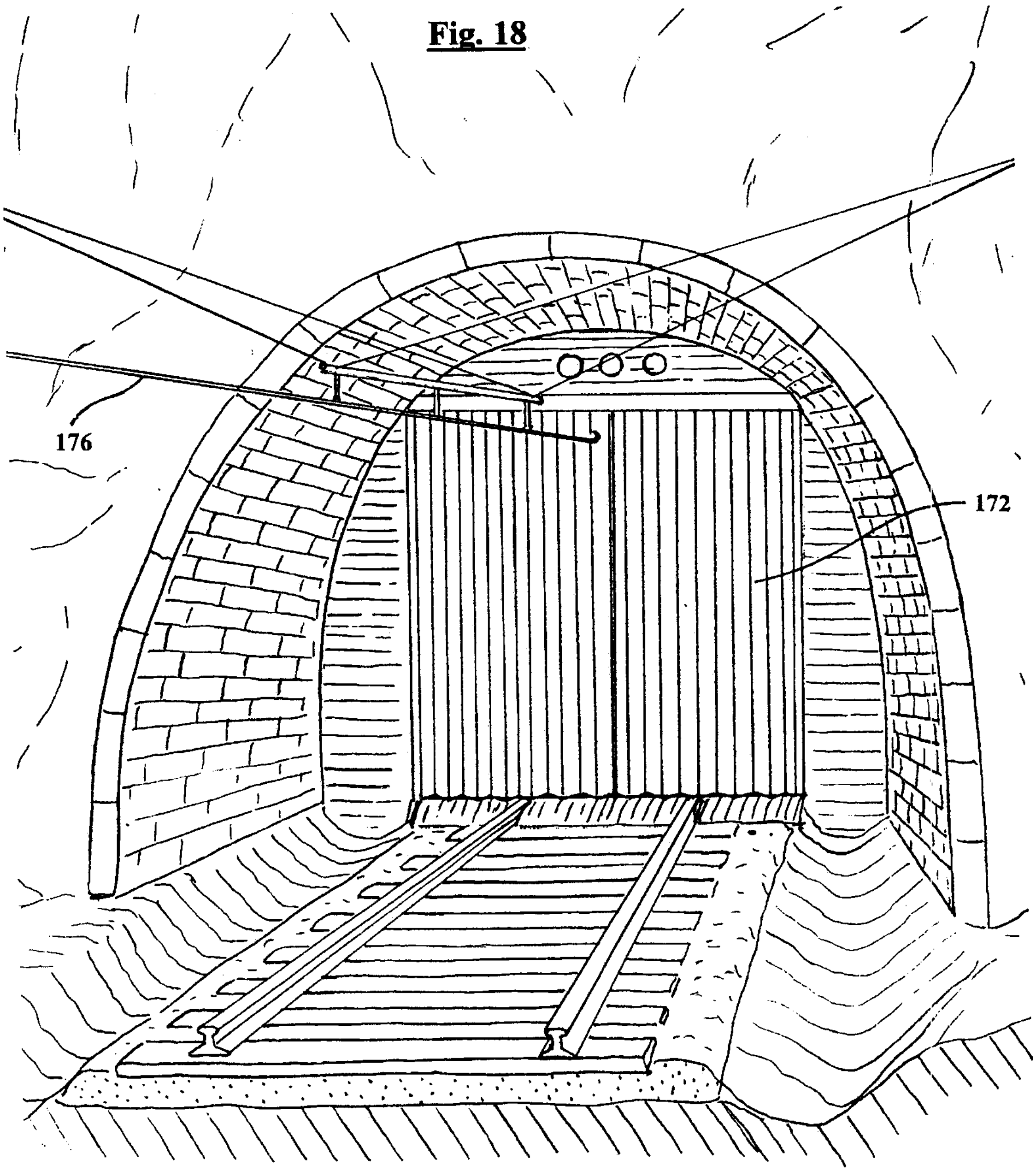


Fig. 17

Fig. 18



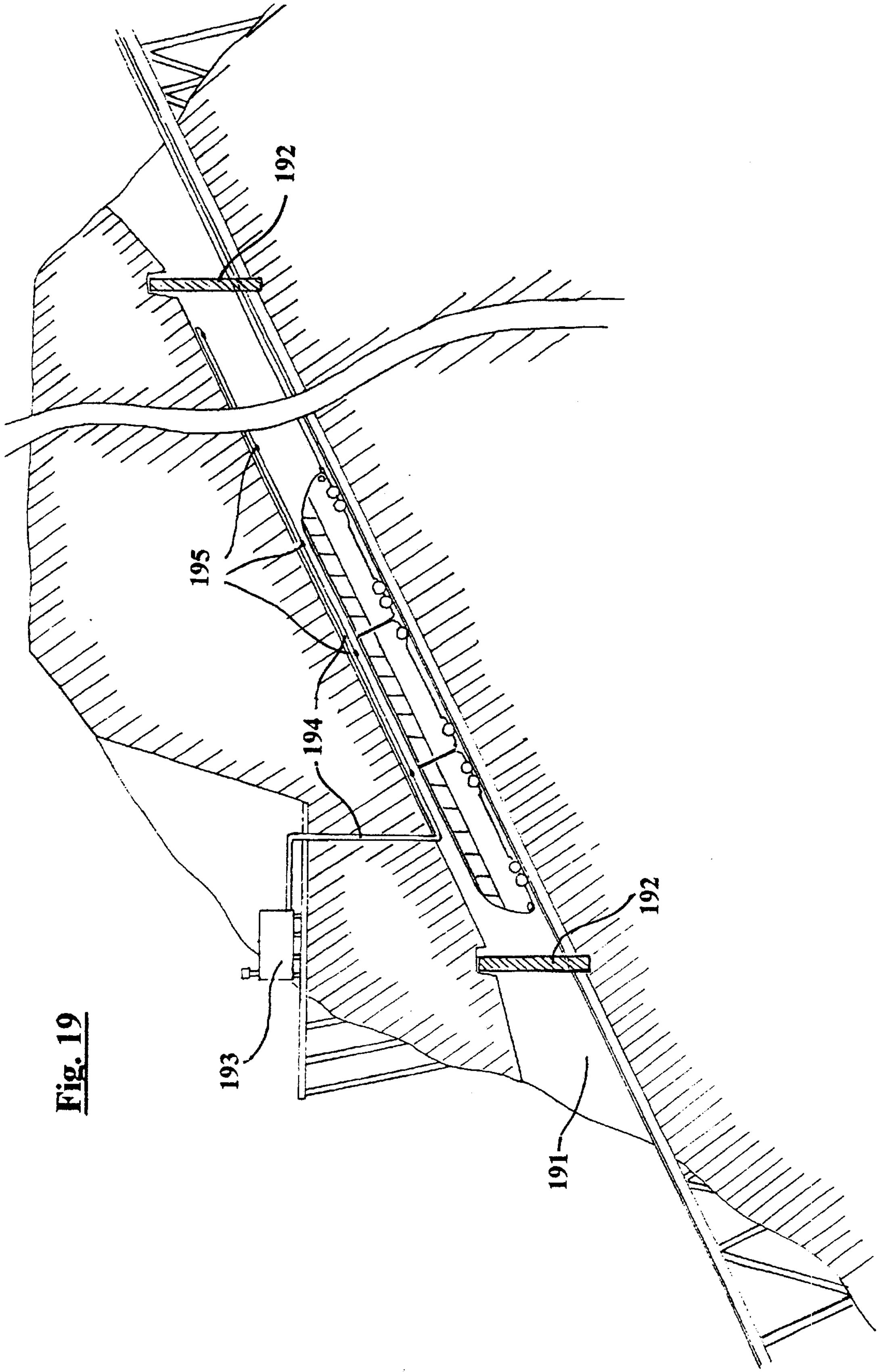


Fig. 19

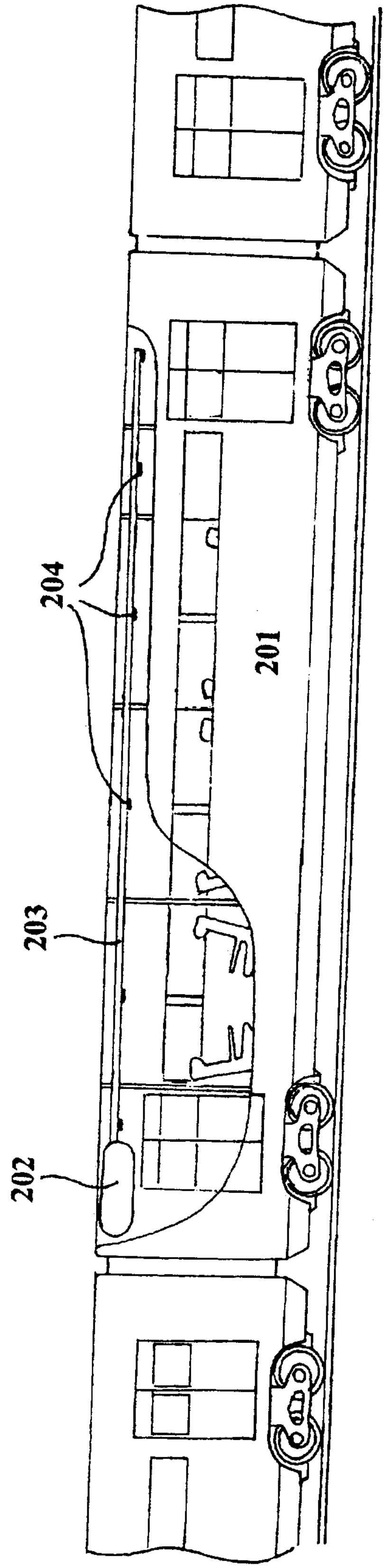
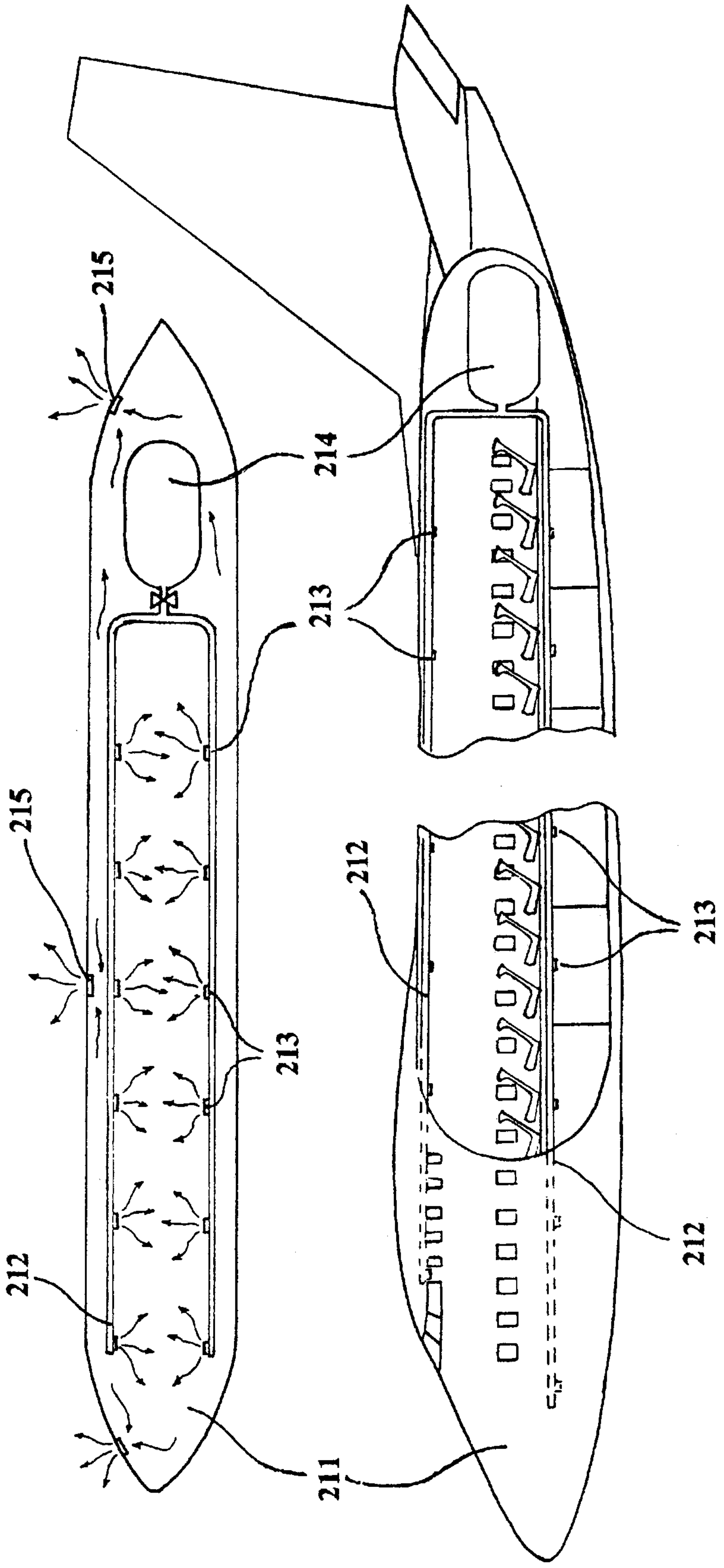


Fig. 20

Fig. 21



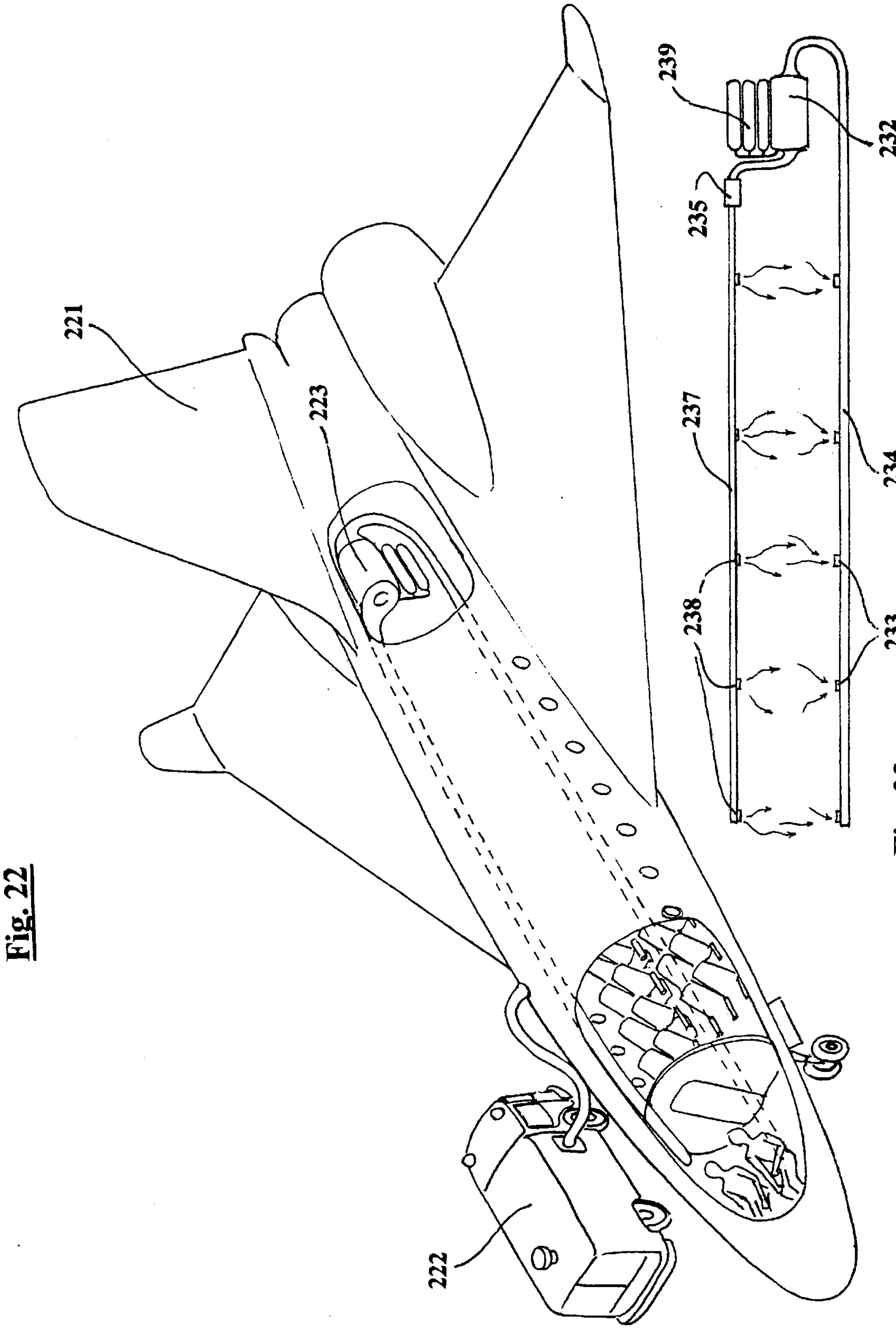


Fig. 22

Fig. 23

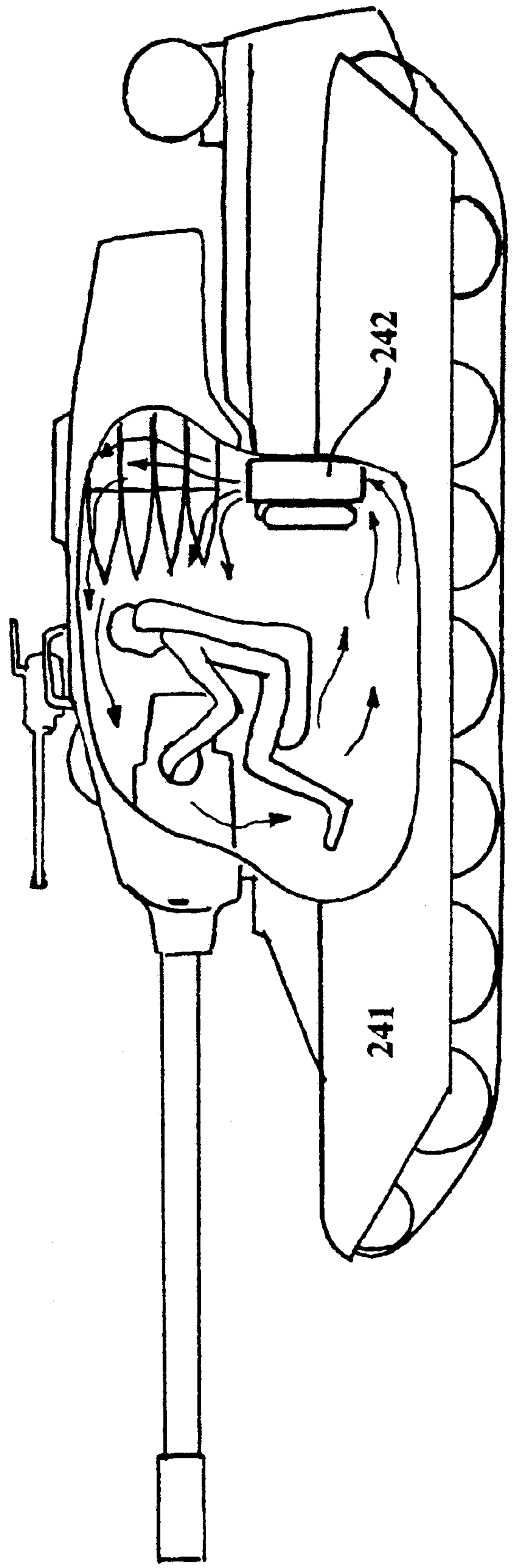
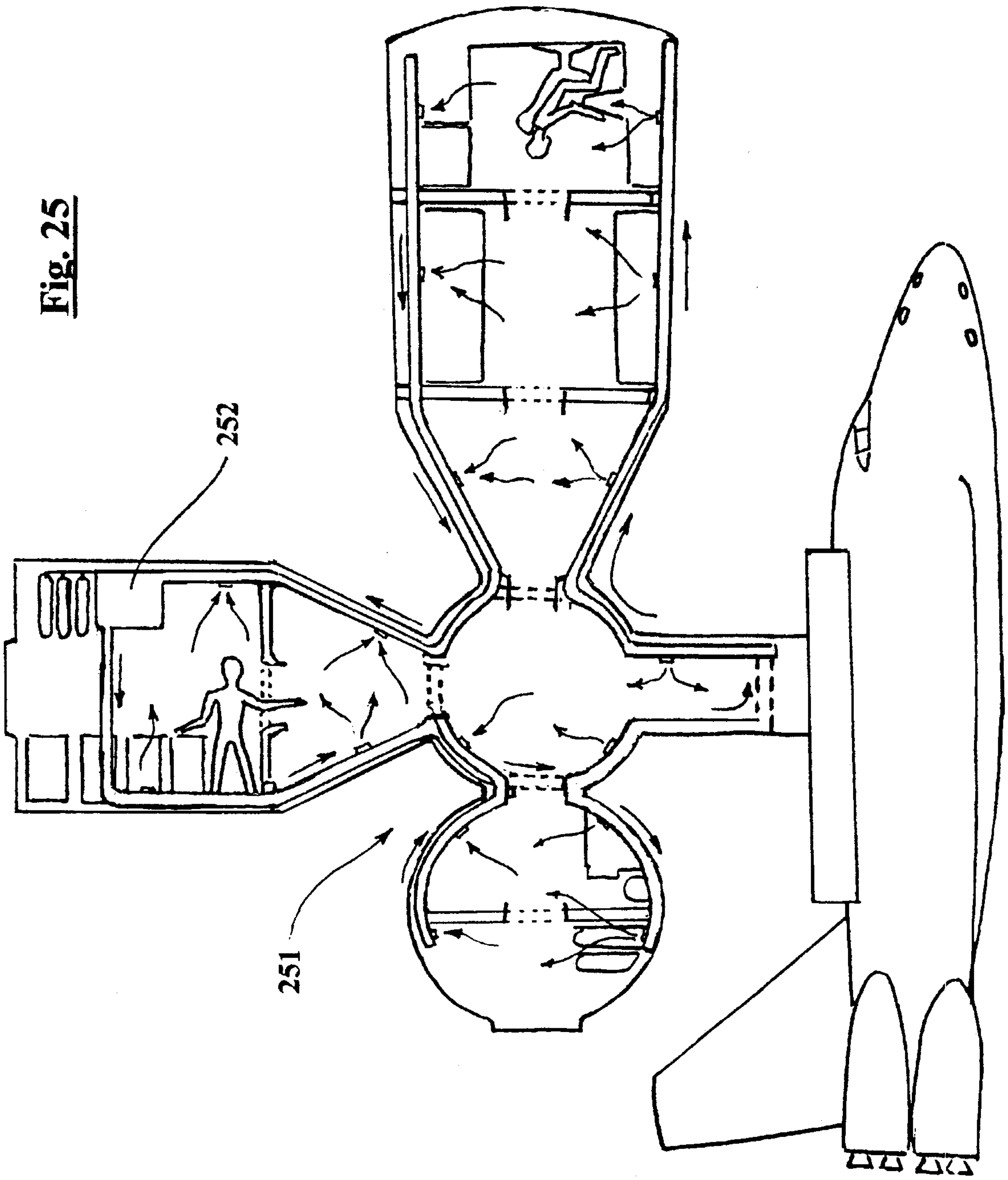


Fig. 24

Fig. 25



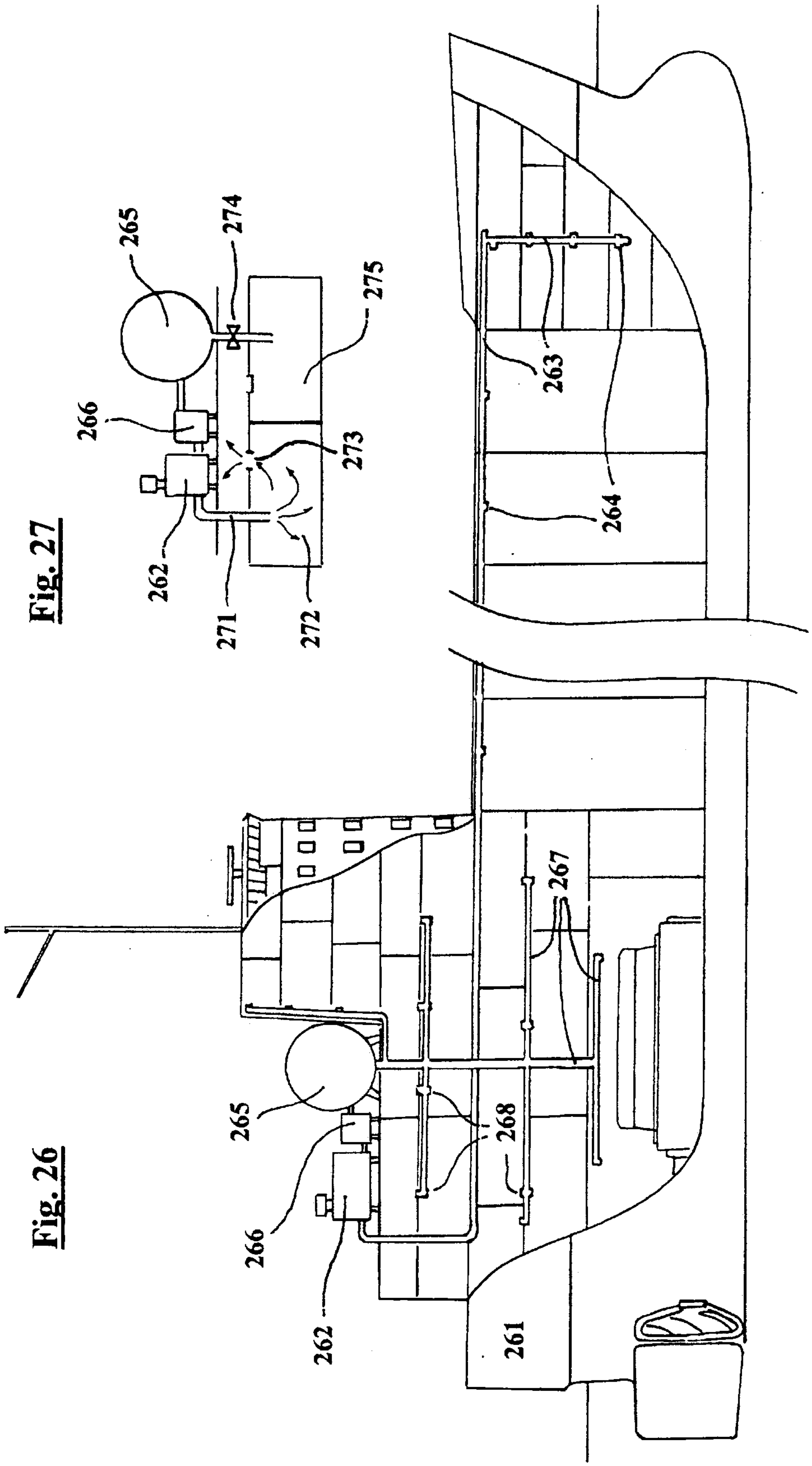


Fig. 27

Fig. 26

HYPOXIC FIRE PREVENTION AND FIRE SUPPRESSION SYSTEMS AND BREATHABLE FIRE EXTINGUISHING COMPOSITIONS FOR HUMAN OCCUPIED ENVIRONMENTS

This application is a continuation in part of U.S. patent application Ser. No. 09/555,026 "Hypoxic Fire Prevention and Fire Suppression Systems for computer rooms and other human occupied facilities", filed Apr. 17, 2000 now U.S. Pat. No. 6,314,754 B1.

RELATED APPLICATIONS

This invention is related in part to preceding U.S. Pat. No. 5,799,652 issued Sep. 1, 1998.

1. Field of the Invention

The present invention introduces the method, equipment, and composition of a revolutionary fire prevention/suppression system that utilizes a low-oxygen (hypoxic) environment to:

Instantly extinguish an ongoing fire

Prevent a fire from getting started.

With its mode of action based on the controlled release of breathable fire-suppressive gases, this human-friendly system is completely non-toxic, fully automated, and entirely self-sustaining. Consequently, it is ideally suited to provide complete fire protection to houses, industrial complexes, transportation tunnels, vehicles, archives, computer rooms and other enclosed environments.

With the majority of fires (both industrial, and non-industrial) occurring at locations with a substantial amount of electronic equipment, this Fire Prevention and Suppression System (FirePASS™) has the added benefit of requiring absolutely no water, foam or other damaging agent. It can therefore be fully deployed without causing harm to the complex electrical equipment (and its stored data) that is destroyed by traditional fire suppression systems.

While this is extremely important to technology-intensive businesses such as banks, insurance companies, communication companies, manufacturers, medical providers, and military installations; it takes on even greater significance when one considers the direct relationship between the presence of electronic equipment and the increased risk of fire.

2. Description of Prior Art

Current fire suppression systems employ either water, chemicals agents, gaseous agents (such as Halon 1301, carbon dioxide, and heptafluoropropane) or a combination thereof. Virtually all of them are ozone depleting, toxic and environmentally unfriendly. Moreover, these systems can only be deployed post-combustion. Even the recent advent of the Fire Master 200 (FM 200) suppression system (available from Kidde-Fenwal Inc. in the U.S.A.) is still chemically dependant and only retards the progression of fire by several minutes. Once this fire-retarding gas is exhausted, a sprinkler system ensues that results in the permanent destruction of electronic equipment and other valuables.

Exposure to FM-200 and other fire-suppression agents is of less concern than exposure to the products of their decomposition, which for the most part are highly toxic and life threatening. Consequently, there is no fire suppression/extinguishing composition currently available that is both safe and effective.

In terms of train, ship, or airplane fires, the inability to quickly evacuate passengers creates an especially hazardous situation. The majority of the passengers who died in France's Mont Blanc tunnel fire suffocated within minutes. In this case the problem was further compounded by the presence of ventilations shafts. Originally designed to provide breathable air to trapped people, these shafts had the unfortunate side effect of dramatically accelerating he fire's propagation. Especially devastating is the "chimney effect" that occurs in sloped tunnels. An example of this was the fire that broke out in Kaprun's ski tunnel in Austrian Alps.

In addition, ventilation shafts (which are present in virtually all multilevel buildings and industrial facilities) significantly increase the risk of toxic inhalation. This problem is further compounded by the frequent presence of combustible materials that can dramatically accelerate a fire's propagation.

While the proliferation of remote sensors has led to significant breakthroughs in early fire-detection, improvements in the prevention/suppression of fires has been incremental at best. For example, the most advanced suppression system to combat tunnel fires is offered by Domenico Piatti (PCT IT 00/00125) at robogat@tin.it. Based on the rapid deployment of an automated vehicle (ROBOGAT), the Robogat travels to the fire site through the affected tunnel. Upon arrival it releases a limited supply of water and foam to initiate fire suppression. If necessary, the Robogat can insert a probe into the tunnel's internal water supply for continued fire-suppression. This system is severely limited for the following reasons:

The time that lapses between the outbreak of fire and the arrival of the Robogat is unacceptable.

The high temperatures that are characteristic of tunnel fires will cause deformation and destruction of the monorail, water and telecommunication lines.

The fire-resistance of the Robogat construction is highly suspected.

The use of water and foam in high-temperature tunnel fires is only partially effective and will lead to the development of highly toxic vapors that increase the mortality of entrapped people.

There are only 4 current methods of fire suppression in human-occupied facilities:

The use of water

The use of foam

The use of chemical flame inhibitors

The use of gaseous flame inhibitors

The present invention employs a radically different approach: the use of hypoxic breathable air for the prevention and suppression of fire. This hypoxic environment completely eliminates the ignition and combustion of all flammable materials. Moreover, it is completely safe for human breathing (clinical studies have proven that long term exposure to a hypoxic environment has significant health benefits). Hypoxic breathable air can be inexpensively produced in the necessary amount through the extraction of oxygen from ambient air.

In terms of fire prevention, a constantly maintained hypoxic environment can completely eliminate the possibility of fire while simultaneously providing an extremely healthy environment. In terms of suppression, this invention can instantly turn a normoxic environment into a hypoxic environment with absolutely no adverse effects to human life. This is extremely useful in the case of a flash fires or explosions.

Based on the exploitation of the fundamental differences between human physiology and the chemo-physical properties of combustion, this entirely new approach completely